INDUSTRIAL DESIGN STRATEGIES FOR SUSTAINABLE DEVELOPMENT

A CASE STUDY OF THE PACKAGING INDUSTRY IN SINGAPORE

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A THESIS SUBMITTED FOR THE DEGREE OF MASTER OF ARTS

(INDUSTRIAL DESIGN)

DIVISION OF INDUSTRIAL DESIGN

NATIONAL UNIVERSITY OF SINGAPORE

2012

ABSTRACT

This study seeks to investigate current design tools being used in the packaging industry of Singapore during the product development stages. Furthermore, this research aims to encourage the creation of more sustainable products as well as to contribute to a more practical approach for sustainable design, bringing benefits to business and to other parties involved. Therefore, this study shows some of the existing Industrial Design strategies for sustainable development taking place in Singapore by investigating into representative cases from the packaging industry.

On account of the growing amount of waste in Singapore and its limited land, the government has developed a special plan for solid waste management, which includes special measures regarding the reduction of domestic waste. In Singapore, about one third of total domestic waste in 2009 was packaging waste (SPA, 2010). Therefore, several of these initiatives are directly related to the packaging industry which allowed me to observe and analyse the Industrial Design responses to some of these programs in its early stages.

The outcomes of this study comprise a critical analysis of the design tools and methods being currently used by the packaging industry in Singapore towards sustainable development; an analysis of some of the products developed by these companies within the given context; a profile of the consumers of the sector studied; as well as a profile of the packaging industry of Singapore regarding sustainable development initiatives with respect to local and global scenarios.

ACKNOWLEDGEMENTS

I would like to express my gratitude to my supervisor, Dr. Christian G. Boucharenc, whose expertise, understanding, and patience, added considerably to my graduate experience. I would also like to thank Dr. Yen Ching Chuan for all the assistance he provided during the development of this research project. I would also like to thank Dr. Carlos Montana for his friendship and guidance.

A very special thanks goes out to Daniel, life partner and best friend, for his everyday patience, kindness and support. I would also like to thank my family for all the love and encouragement they have always given me.

In conclusion, I would like to express my gratitude to the financial assistance of the National University of Singapore. This research would not have been possible without the NUS Graduate Research Scholarship.

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1 AN INTRODUCTION TO THE THESIS

“Design is the conscious effort to impose a meaningful order.” Papanek, V. (1985)

1.1 Personal motivation

The environmental impact of human activities on the planet earth is directly related to three main factors: the number of people on the planet, the amount of resources used by each person and the environmental pollution and degradation caused by the use of such resources (Corson, 1994).

From this perspective, it is not difficult to see that most of the attempts and alternatives proposed worldwide to deal with this problem usually deal with second mentioned factor. Recycling and reuse of products and materials and environmental awareness educational programs are examples of alternatives proposed to lessen the growing amount of resources consumed by each person on the planet.

It is undeniable that a significant reduction of resources and materials used would lessen the harm to the environment. Nevertheless, such actions are efficient only at attenuating the problem. The third mentioned factor has been identified as the real cause of the negative environmental impact of human activities on the planet (McDough and Braunghart, 2002). Therefore, the problem of environmental pollution and degradation caused by the use of such

resources can only be solved once I change the way I use the resources to generate energy and make products to a totally clean, non pollutant alternative.

Moreover, as discussed by McDough and Braunghart (2002), if such an alternative is ever developed and put into practice; as to say, if new materials and technologies are developed in accordance with the environment or even as an integrated part of it, then the growth of the population or of the use of resources may no longer be a problem. But how could such an alternative be developed? Would there be a way of making clean products and clean energy? In that case, would there be a sustainable way of doing so? And then, what would be the role of Industrial Design within this new context?

As a first step I believe it is important to completely understand the actual situation, so as to be able to start proposing better alternatives. Sustainable development and Industrial Design are the main focus of this research project. In order to facilitate the analysis of such broad concepts, this study proposes the investigation of their interaction within a more specific context, namely the packaging industry in Singapore.

1.2 Introduction

The economy of the Asian developing countries has been described as the largest economy in the developing world (Chiu & Yong, 2004). The Asian economy has experienced the most rapid increase in its history in the last two decades, bringing undeniable short term benefits to these countries. However, such rapid growth has also brought several environmental challenges which include sand storms, acid rain, floods, forest depletion, solid waste pollution,

among others. As a possible solution to these problems, several authors including Chiu and Yong (2004) have suggested the need for a sustainable development strategy.

The more I analyse the problems of the modern society, the more I see that most of them are interconnected, mutually dependent, and cannot be treated separately. Most of the attempts to define 'sustainable development' require that I understand the earth as a system that interconnects social and economic development and environmental protection over space and time. In developed countries, the changes required are mostly limited to integrating environmental concerns into peoples' lives as well as into political and economic decisions. However, in developing countries, social, economic and environmental issues tend to need more substantial considerations (Mitchell, 1994).

In the current scenario, where everything must be planned and projected, the Design comes as a powerful tool allowing people to mould their objects, their services, their environment and consequently the society itself (Papanek, 1985).

The republic of Singapore is a country located on the southern part of the Malay Peninsula in Southeast Asia. An island of 660 Km2, it brigades a population of 4.7 million people. Over the past 40 years the government has implemented and updated different plans for the continuous development and economic growth of the country. As a result, Singapore has been described as the most successful economy in Southeast Asia, ahead of South Korea, Hong Kong and Taiwan (Lim, 1983). However, Singapore is still on its early stages of

development regarding sustainability issues, compared to some European countries (Chiu and Yong, 2004).

As relatively small country, Singapore continually faces the problem of limited land, especially in terms of solid waste management. Regarding this matter, the Singaporean government has launched a series of programs, which are assessed in this study with respect to the Industrial Design context.

In Singapore, about one third of total domestic waste in 2009 was packaging waste (SPA, 2010). Therefore, several of these initiatives are directly related to the packaging industry which allowed me to observe and analyse the Industrial Design responses to some of these programs on its early stages. Therefore, this study shows some of the existing Industrial Design strategies for sustainable development taking place in Singapore by investigating into representative cases from the packaging industry.

The case study methodology was chosen as the most suitable research strategy for the purpose of this study since its application is suggested for research questions dealing with contemporary events where the relevant behaviours cannot be controlled (Yin, 1994). Regarding the packaging industry in Singapore, the case study methodology is used in the analysis of two different contexts: multinationals and local companies. Specific strategies within each of these contexts are identified and analysed. The data collected comprises companies' Interviews, Consumers' surveys, and analysis of product samples.

1.3 The research structure

The following research structure was created for the development of this study. The structure is composed of several stages that can be divided into two main phases. The first phase illustrates the process used in the definition of the research topic, while the second phase describes the strategy used to approach the proposed problem and to obtain the results.

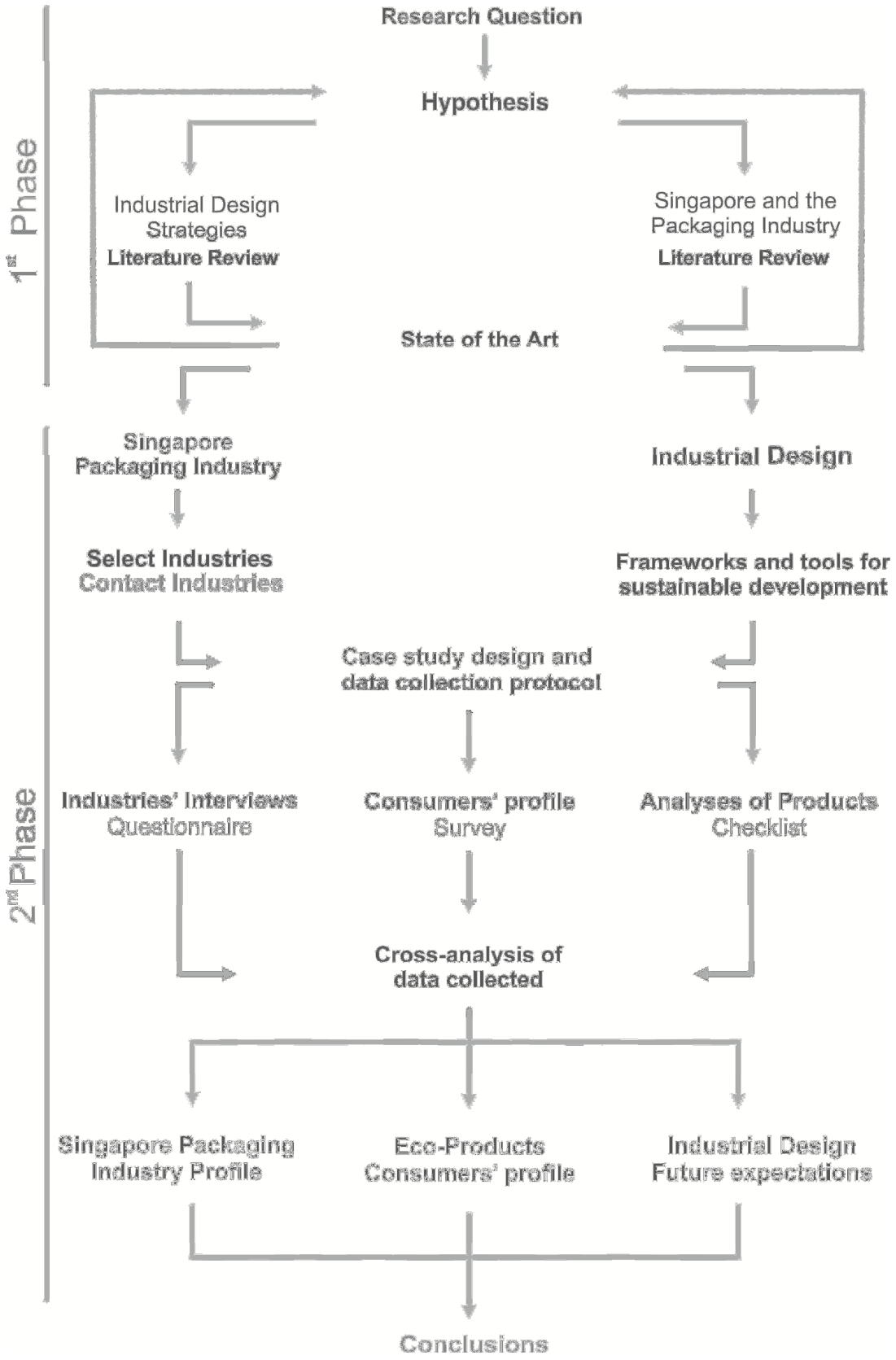

Figure 1. The research structure

1.3.1 1st Phase

The first phase of the research was structured to allow a more accurate definition of the research topic. On the first steps of this phase the research questions and the hypothesis are proposed based on previous literature review; the structure is then divided into two parallel stages conducting further literature review in the main areas of focus: Industrial Design and sustainable development and the packaging industry in the context of Singapore. The next step includes the cross analyses of these two areas, allowing a better definition of the research scope and the evaluation of the proposed hypothesis in relation to the two areas of focus proposed. A loop is then introduced in the structure allowing the restart of the process in case the literature review findings are not in accordance with the previously proposed research hypothesis and questions. Following the definition of the research scope, the structure is once more divided into the two main frameworks of this study: Industrial Design and sustainable development and the packaging industry in the context of Singapore.

1.3.2 2nd Phase

The second phase of the research describes how the proposed problem was approached. On the first stage of this phase the structure is divided into the two main frameworks of this study: the packaging industry of Singapore and the Industrial Design context. On the left side I have the packaging industry of Singapore being analysed. At this stage companies are selected and invited to collaborate with the research project. In parallel I have the Industrial Design

context being analysed in terms of existing methodologies and tools for sustainable development. Subsequently, the information from both contexts is put together and the most suitable methodology for this research context is selected. The case study design and the data collection protocol are then developed, including the elaboration of three main tools to be used as source of information: a questionnaire to serve as guideline for the industries interview; a survey for the creation of a consumers' profile, and finally a checklist to assist the analysis of pre-selected products. As can be seen in figure 1, the next stage brings the three sources of information together in a cross analysis of the data collected. Arising from such analysis I have the elaboration of the three main outcomes of this project and their following presentation. They are:

- A profile of the packaging industry of Singapore regarding sustainable development initiatives with respect to local and global scenarios;
- A critical analysis of the design tools and methods being used by the packaging industry in Singapore towards sustainable development and
- A profile of the environmentally friendly consumers of Singapore.

2 THE RESEARCH STEP BY STEP

The following chapters present a detailed description of this research project following the structure shown in the last section. For that, each stage of the two phases previously mentioned are described step by step from the definition of the research topic, to the final conclusions.

2.1 The topic definition

At this point it is important to highlight that different frameworks were considered. The first phase of the research structure was developed to assist the identification of the most adequate scope. Based on my personal motivations and literature review, several questions and hypothesis were proposed in order to be able to identify the most adequate framework for the development of this research. Different frameworks were identified and submitted to the first phase of the research structure.

The following sections show the analysis of the selected framework ‘step by step’ and the subsequent definition of the research scope.

2.2 1st phase

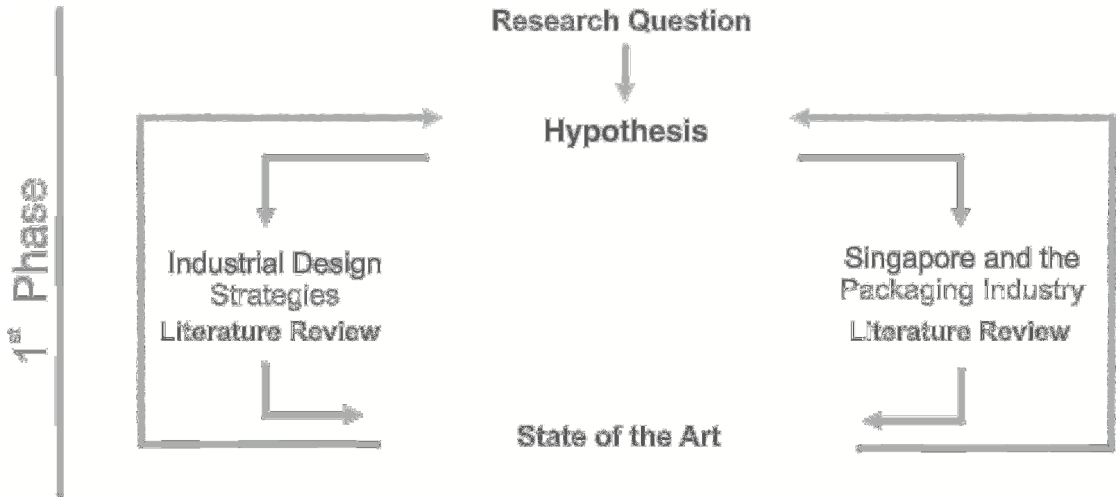

Figure 2. The research structure - Phase 1

2.2.1 Research question

Two research questions are proposed for the investigation into the Industrial Design strategies taking place in the packaging industry in the context of Singapore towards sustainable development.

Research questions:

_ What are the current product design strategies being implemented in the Singapore packaging industry towards sustainable development?

_ How are these strategies being implemented?

In addition, several guideline questions are also proposed for field observation, interviews and questionnaire elaboration:

• In which stages of the product development are the identified strategies being implemented?

• How and which extent are these strategies being implemented? And in which phases of the product development?

• How are the Industrial Designers involved in the implementation of these strategies in the companies?

• Is it possible to develop design tools/methods that contribute to the development of the selected industrial sector in Singapore?

• What would be a suitable manner of making such tools/methods available to the selected industrial sector?

• Do the companies analysed have a clear understanding of the following concepts?

'Sustainable development'

'Eco-design'

'Sustainable design'

'Product Life Cycle'

'Eco-efficiency'

• How do consumers in Singapore respond to sustainable development initiatives, from the government programs to 'eco-products'?

2.2.2 Hypotheses

Based on the Singapore background, the research questions and on previous literature review, the following hypotheses are presented:

- It is important to develop and implement specific sustainable design methodologies and tools to each industry sector;
- The packaging industry of Singapore is in its early stages of developing design tools for sustainable product development;
- Specific tools for the packaging industry in Singapore have not been developed yet.

2.2.3 Objectives

General Objective

This project seeks to investigate into current design tools being used in the packaging industry of Singapore during the product development stages. Furthermore, this research aims to encourage the creation of more sustainable products as well as to contribute to a practical approach for sustainable design, bringing benefits to business and to other parties involved.

Specific Objectives

- To study the development of sustainable design tools that can be effectively applied to the packaging industry of Singapore;

- To analyse the tools and methods being used, as well as some of the products developed in this context;
- To generate a profile for the packaging industry of Singapore with respect to sustainable development initiatives;
- To facilitate the future development of a customised toolkit for the selected industrial sector.

2.2.4 Methodology

In order to analyse the selected sector within the given context, the case study methodology is proposed.

The case study methodology is the most suitable research strategy for the purpose of this study since its application is suggested for research questions dealing with contemporary events where the relevant behaviours cannot be controlled. In addition, according to Yin, (1994) *"...the case study's unique strength is its ability to deal with a full variety of evidence-documents, artifacts, interviews, and observations…"* The cases to be studied shall be selected from representative cases and each case should serve a particular purpose within the general investigation scope. Thus, each case should be analysed and compared based on interviews, field observation, historical data and other sources of information, according to previous developed protocol. It is also important to consider the availability of the industries to take part in the study. Therefore, two possible approaches are proposed regarding the industries availability or not.

2.2.5 Case Study Design

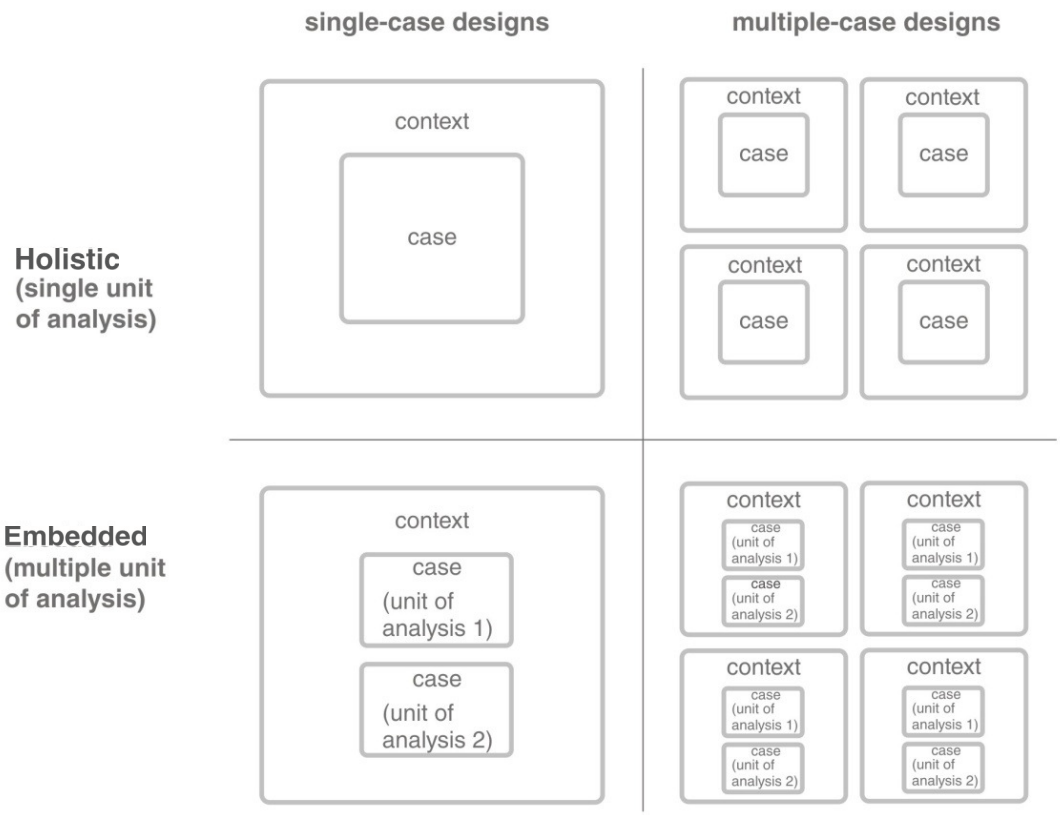

Figure 3. Basic types of design for case studies (Yin 1994)

According to the scheme above the most suitable case study design for this research is the Embedded Multiple case study.

Thus two possible approaches are proposed:

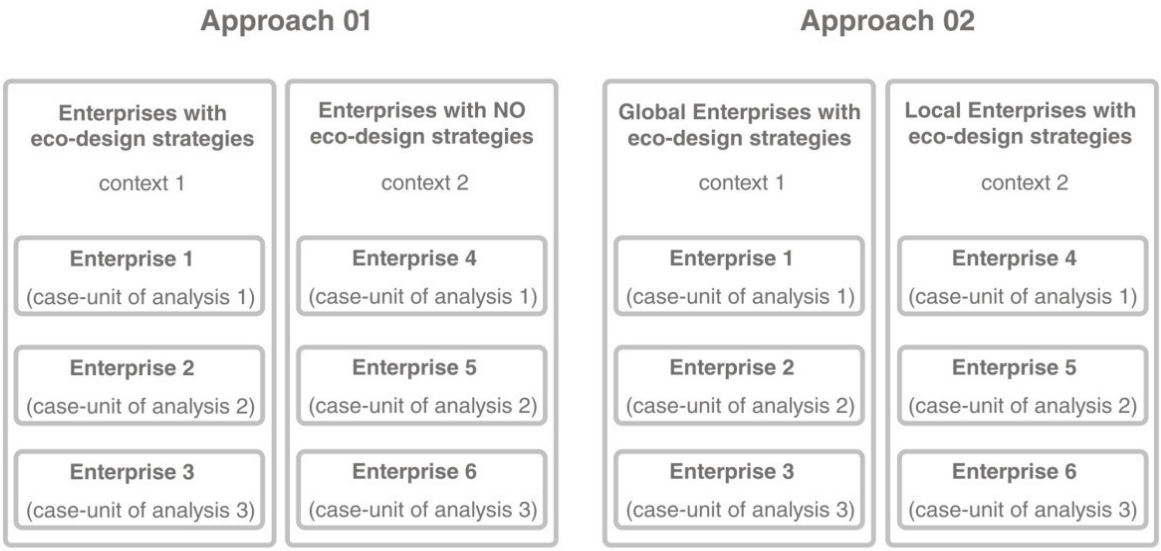

Figure 4. Possible approaches to the case study. Adapted from Yin (1994)

The first approach proposes the study and subsequent comparison between industries that have Eco-design strategies and industries which do not have Eco-design strategies. That approach would allow me not only to study the current tools being used by the companies that have Eco-design strategies; but also to investigate the reasons that generally drive a company to engage or not in such activities.

The second approach proposes the study and comparison among multinationals and local companies in Singapore in order to identify specific strategies within each context, and later establish a comparison between them. This might also be an interesting approach for the purpose of this research, as there are many multinational packaging companies in Singapore that have already experienced the process of developing more sustainable products in

the European context, in contrast to local Singaporean companies that have just started dealing with the situation.

2.2.6 Expected Outcomes

The expected outcomes of this research project include:

- A critical analysis of the design tools and methods being used by the packaging industry in Singapore towards sustainable development;
- Analysis of some of the products developed by the companies studied within the given context;
- A profile of the packaging industry of Singapore with respect to sustainable development initiatives;
- A Website/blog displaying the research results in order to contribute to the development of sustainable design in the packaging industry of Singapore.

3 THE LITERATURE REVIEW

This chapter comprises the literature review on the main two topics of this thesis; the Industrial Design discipline and the packaging industry of Singapore in the context of sustainable develop*ment*. The first section introduces the concept of sustainable development emphasising its holistic approach; secondly, the Industrial Design discipline is introduced as a design discipline and finally a brief overview on systems thinking is presented. Two different approaches of Industrial Design are then introduced as examples of integrative thinking in Industrial Design. Finally, the last section presents a potential framework for the development of this study, introducing the Industrial Design strategies of the packaging industry of Singapore with regard to sustainable development.

3.1 Industrial Design and Sustainable development

3.1.1 Sustainable development

The more I analyse the problems of the modern society, the more I see that most of them are interconnected, mutually dependent, and cannot be treated separately. Most of the attempts to define 'sustainable development' require that I understand the earth as a system that interconnects social and economic development and environmental protection over space and time (Mitchell, 1994). According to World Commission on Environment and Development definition which is widely used since 1987; sustainable development is:

> *"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs." (WCED, 1987)*

From these perspectives, 'sustainable development' does not imply any specific pattern of development or guideline. In fact, such broad definition rather suggests that each country, region, or community shall develop alternatives, in accordance with its local character to achieve sustainable development. In developed countries for instance, the changes required would be mostly limited to integrating environmental concerns into peoples' lives as well as into political and economic decisions. However, in developing countries, social, economic and environmental issues tend to need more substantial considerations (Mitchell, 1994).

Furthermore, Glavic and Lukman's (2007) definition highlights the focus on the three pillars of sustainable development:

> *"Sustainable development emphasises the evolution of human society from the responsible economic point of view, in accordance with environmental and social aspects."*

Proposing a more holistic and practical approach, they imply that only by equally considering economic, social and environmental, aspects that sustainable development could be achieved. The same holistic approach can also be observed in some research disciplines, particularly in those related to environmental studies, where a system is frequently considered not only as the sum of its parts but mainly as the integrity of the relationship between them. Such approach comes from systems theory's application to several research

areas, more specifically from the application of integrative approach, which will be explained in detail in the ‘systems thinking’ section.

3.1.2 Design

The definitions and perceptions regarding the concept of design have changed throughout history. According to Montana-Hoyos, (2010), Design has been considered as an art, a science, a problem-solving method and even as a language or a way of communication.

Moreover ‘design' can be understood as

> *“… the planning or calculation of the form, dimensions, materials and general specifications of an artificial (man-made) product (understanding by product a service, system, space or object), which are determined by human necessities (of utility, comfort, beauty, emotion and communication, among others). This planning is done in diverse scales that go from the conception of small utility products (industrial or product design) to the conception of cities (urban design). Recently the word design is used to describe not only the creation of objects or material ‘things’, but in general the planning of processes and systems in many disciplines.” (Montana-Hoyos, 2010, p43).*

In addition, Mc Dermott (2007) describes ‘design as an ever-expanding discipline which is at the intersection of a range of disciplines’ being constantly shaped by economic, social and cultural aspects. According to Mozota (2003), the different types of design can be classified in three categories or dimensions. In two dimensions I have Graphic Design and Information Design, among

others; in three dimensions I have Industrial Design, Fashion Design and Interior Design as examples; finally, web design and interactive Design are some of the design disciplines classified in the four dimensions category. Such design disciplines are closely interconnected operating on different levels of complexity and scale (Montana-Hoyos, 2010).

This study is limited to the Industrial Design discipline. Moreover, I am mostly interested in the methods and tools of this discipline which are directly related to the development of sustainable products and services. The next section introduces the Industrial Design discipline emphasising the significance of interdisciplinary approaches when dealing with sustainable development issues.

3.1.3 Industrial Design

The modern industrial age in which design and technology play such significant roles is relatively new. Before the industrial revolution, between the 18th and the 19th centuries, objects were mainly created by artisans and craftsmen. It was only then, that term Industrial Design was introduced to describe the activity of adapting the new products of industry to mass production. (McDermott, 2007). A recent definition from The International Council of Societies of Industrial Design (ICSID, 2011) describes the Industrial Design discipline as

> *"a creative activity whose aim is to establish the multi-faceted qualities of objects, processes, services and their systems in whole life-cycles. Therefore, design is the central factor of innovative humanization of technologies and the crucial factor of cultural and economic exchange."*

This is certainly a broad definition; however, it is important to note that the concept of integrative thinking is somehow already mentioned here considering the three aspects of sustainable development. The environmental aspect is highlighted through the consideration of objects, processes and services' lifecycles; the social aspect is mentioned through the ideas of 'humanization of technologies' and 'cultural exchange'; and finally the economic aspect is emphasized as a 'crucial factor'.

Let us now move to a more practical definition of Industrial Design summarised by Papanek (1971):

> *"Design has become the most powerful tool with which man shapes his tools and environments (and, by extension, society and himself)." P.ix*

Presenting a further practical approach, this definition recognises Industrial Design as the tool through which I am able to modify our environment.

By combining this two definitions, as to say, the need for a systemic way of thinking Industrial Design and the recognition of this discipline as a 'powerful tool' which allows me to shape our environment, I can argue that 'an ideal approach to contemporary design should transcend the barriers of the different disciplines, aiming for a holistic, transdisciplinary and systemic approach to design. (Montana-Hoyos, 2010).

Some of the existing Industrial Design approaches already recognise the need for a systemic way of thinking Industrial Design. Eco-Design and Design for sustainability are examples of such approaches, which will be discussed later in this thesis.

3.1.4 Overview of Systems Thinking

This section is an adaptation of the article written by the author of this thesis together with Carlos Montana-Hoyos (Montana-Hoyos and Tenuta, 2010) and later published as part of the book *BIO-ID4S: Biomimicry in Industrial Design for Sustainability*. by Montana-Hoyos.

In the first half of the 20th century, 'systems thinking' has had a great influence from biological and environmental sciences, having living systems as common examples of systemic and holistic thinking and interdisciplinarity. On the other hand, only recently the Industrial Design discipline has applied such systemic and interdisciplinary thinking to some of its practical approaches such as Eco-design and Design for Sustainability (DfS).

In order to understand the evolution and state of the art of systems thinking, it is important to look back in history to understand different key periods that shaped its development. This brief overview of systems thinking provides mainly a background to understand why the studies of nature and the environment have been definitive in systems thinking, and thus why such integrative approach became so relevant in the current Industrial Design scenario.

Let us start by saying that the notion of life as something which could not be understood by science, physics or chemistry, but which was determined by inexplicable 'non-material', 'non-measurable' forces. Also known as 'vitalism' (Allen, 2005), this principle which relates life to a mysterious and unknown 'vital energy' or 'soul' has its roots in ancient Egypt and was a common belief in many ancient civilisations. The idea of a spiritual, organic and living universe

based on Christian theology and Aristotelian philosophy was largely accepted until the 16th century, when Rene Descartes first introduced the concept of ‘mechanism’ (Capra, 1996). At this point, it is very important to mention that this concept has assumed different connotations throughout history, depending on the context in which it has been situated. In this paper I am mainly interested in two of these meanings. First, the philosophical concept of ‘mechanism’ which proposes the view of the earth and the living systems as working machines; and second, the practical approach which proposes the analysis of a given subject by breaking it into smaller pieces in order to understand the whole by the properties of its parts (also known as reductionism, and usually opposed to the idea of holism, described later).

These concepts were some of the main foundations of the scientific revolution and influenced the western sciences for almost three centuries, bringing unforeseen development in several disciplines including Mathematics, Physics and Astronomy. However, during the first half of the 20th century, different movements emerged in several fields of science where the mechanistic view was no longer appropriate. In this scenario, three different disciplines which had the living systems as their main object of study moved towards a new way of thinking, proposing a shift from mechanistic to systemic thinking.

Within this transition, organicist biologists proposed a new way of understanding life and nature rejecting previous vitalism, reductionism, and mechanism. According to Allen (2005), organicist biologists proposed the understanding of organisms as whole and complete entities, being the whole not just the sum of its parts, but mainly the integrity of the relationships between them.

Having the organicist biologists as the pioneers, such movement was reinforced by different disciplines as the Gestalt psychology, the new science of Ecology and the Quantum Mechanics theory (Capra, 1996). These alternative approaches were the first steps towards what I know today as 'Systems Theory'. In all these fields, the scientists realised that the systems they studied required to be treated as integrated wholes whose properties could no longer be reduced to smaller parts.

The development of the Gestalt psychology played a significant role in the systems thinking history as it also supported the paradigm shift from the parts to the whole. First introduced in Psychology by Christian von Ehrenfels, the concept of 'gestalten' is used to describe states and events whose properties and effects cannot be simply reduced to the sum of its parts (Arnheim, 1998). Such concept was recognised by Max Irtheimer in the 1920's while studying human behaviour and perception, and yet reinforced by Kurk Koffka who formally added that *'the central physical processes should be not viewed as sums of single stimulations but as wholes'* (Arnheim, 1998). These were the first steps to the Gestalt therapy which was developed years later. Also in the beginning of the 20th century, another important development that enhanced the systems thinking movement was the rise of the science of Ecology. Considered new at that time, the roots of Ecology are historically diverse, however, the contributions to such field in the early 20th century are believed to be of great importance to the development of Ecology as a formal discipline. According to Kingsland (2004), the idea of network was first introduced during this period, expanding the concept of systems thinking from organisms to communities. Meanwhile, the Quantum physicists also experienced a similar

paradigm change regarding the relationship between the parts and the whole. Ever since Newton it was believed that physical phenomena could be reduced to some properties of individual particles, such as position, speed, mass and so on. However, Schrödinger (1935) and other physicists showed that in Quantum theory particles' properties could only be revealed once they were observed together, as a system. Such development also played an important part in enhancing the rise of systems thinking.

It was not until the 1940s when the systems theory was formally proposed in line with Bertalanffy's concepts of 'open system' and 'general systems theory', consolidating systems thinking as a major scientific movement. Simultaneously, mathematicians, social scientists, neuroscientists and engineers were involved in the development of a new movement, the Cybernetics. The word Cybernetics refers in science to the study of communication and control regarding machines and animals. According to Capra (1996), the Cyberneticists were also concerned about networks and closed-loops which led them into the development of the new concepts of self-regulation and self organisation. During the subsequent years, the systems thinking was largely incorporated into engineering and business administration, since it could be used to predict and solve practical problems.

Another important fact that is worth highlighting is the rise of new Mathematic theories during the 1970s. Chaos theory and Fractal geometry emerged as powerful tools not only for Mathematics studies, but also allowing several developments in different fields. For instance, they made it possible to describe and better comprehend complex systems networks, taking the systems theory to a whole new level. Also during the 1970s, such developments, together with

the new concepts of self-regulation and self-organisation proposed by the Cyberneticists were key ideas used by Lovelock on the formulation of the Gaia hypothesis. Lovelock (1995, 15) proposes the earth as a self-regulating system, in his own words, “Gaia is best thought of as a super organism. These are bounded systems made up partly from living organisms and partly from nonliving structural material.”

In accordance with Deep Ecology, the Gaia theory proposes that human beings, as every other living organism on the planet, are part of a self-organised entangled web. The relatively constant temperature of the planet is one of the examples used by Lovelock to demonstrate how oceanic algae and microorganisms are directly related to the rocks, the oceans and the atmosphere in a cycle that regulates the temperature of the earth. Moreover, the interconnections between all these parts are so deeply entangled that such cycle regulates itself. In other words, the system is so accurately connected that it also acts as a feedback loop, linking the planet’s organisms and the environment in cyclical interactions.

I would like to highlight the significance of systemic, interdisciplinary and holistic thinking in research fields that are closely related to nature and environmental studies. Movements like the Deep Ecology and the Gaia theory, among others, are examples where this particular application plays a definitive role. Similarly, I would like to argue that an integrative perspective within the framework of Industrial Design is fundamental in the context of sustainable development. Such argument is supported by some of the existing Industrial Design approaches such as eco-design and sustainable design; which will be discussed in the following section.

3.1.5 Eco-Design

The concept of eco-design was first introduced in the 60's, when most of the environmental movements were emerging. Rachel Carson's book (1962) "In a Silent Spring", which strongly criticises the widespread use of DDT in agriculture and other fields, can be cited as a determining book in the development of such movements, as it helped increasing public awareness about environmental issues as well as raising pertinent discussions among scientists and politicians at the time.

In the 70's, Victor Papanek was responsible for proposing a more practical approach to environmental issues, being the first to introduce ecological ideas in the context of Industrial Design. In his seminal book 'Design for the real world' published in 1971, he proposes a whole new approach to design emphasising the need for a more ecologically centred design. Such approach is nowadays known as eco-design, green design, environmentally friendly design, or design for the environment (DfE) and, according to Catherine McDermott (2007), it can be defined as

> *"… the principal of determining which strategy and approach will achieve the most environmentally considered design outcome. Eco-design is concerned with maximizing the efficiency of a product or system in terms of energy and use of resources. It considers all the environmental impact of a product throughout its life cycle, alongside standard design criteria such as function, quality and appearance."*

Therefore, eco-design is mostly concerned with the environmental aspects of products and systems throughout their whole life-cycle, including all developing phases, from raw material extraction to final disposal.

Eco-design tools and strategies have been widely developed in the last two decades, ranging from simple checklists to advanced software. They may vary in approach and scope, but are usually focused on the concept of eco-efficiency; proposing a more integrative approach by looking into the products' whole life-cycle. The eco-efficiency concept can be introduced as the combination of eco-design considerations and commercial benefits (BCSD, 1993). Therefore, efficiency could be maximised by minimising resource use for instance, and eventually reducing cost. (Lofthouse, et al. 1999)

In summary, eco-design can be understood as an industrial activity which integrates "environmental considerations into the design process, while (at least) maintaining price, performance, and quality standards." (Lofthouse, et al. 1999)

Specific eco-design tools will be further described and discussed in the second phase of this thesis.

Once the notion of Eco-design has been clarified, let us now look into the concept of sustainable design in an attempt to establish the main differences and similarities between these two approaches.

3.1.6 Sustainable Design

Sustainable design, otherwise known as Design for sustainability (DfS), encompasses “theories and practices for design that cultivates ecological, economic, and cultural conditions that will support human well-being indefinitely.” This Sustainable design definition by Thorpe, (2007) considers an integrative approach to Industrial Design, integrating the three main aspects of sustainable development into the practice of Design. It also embraces the World Commission on Environment and Development definition of sustainable development (WCED, 1987) which has been previously cited, by emphasising the importance of respecting ‘future generations’.

Similarly to eco-design, this definition also approaches product development from a wide point of view. However, when closely compared to eco-design, sustainable design provides a more holistic framework since it “…broadens the focus of what might be called ‘green’ and ‘eco’ thinking to include such issues as social responsibility, ethics and social structures and relations.” (McDermott, 2007).

There are many available tools to assist the implementation of a sustainable design approach into product development phases. Eco-design tools previously described, they range from inexpensive and simpler ones to more expensive and complex tools. Sustainable design encompasses eco-design considering not only environmental aspects as eco-design does, but comprising the three aspects of sustainability. Most of the sustainable design tools consist of existing eco-design tools supplemented by additional components which cover the particulars brought by the considered social aspects. The list below shows

examples of some of the existing Industrial Design tools for Sustainable development. They are the mechanism used to measure or evaluate sustainable impacts:

- Life Cycle Assessment (LCA)
- Total Beauty
- Biomimicry
- Social Return on Investment (SROI)
- Sustainability Helix

Examples of less accessible tools:

ISO 50001, SA 8000, LASER manual, SIGMA, SCORE sustainability assessment, Footprint calculators, LCA standards (ISO, U.S. EPA)

Dealing with complex systems can be a difficult task since many aspects need to be considered and carefully analysed from different points of view. As discussed in the 'systems thinking' section, an integrative perspective within the framework of Industrial Design is fundamental in the context of sustainable development. A product life cycle can be considered as a complex system (Levy, 1995 and Ny et al. 2006)

> *Sustainable management of materials and products requires continuous evaluation of numerous complex social, ecological, and economic factors. (Ny et al. 2006, Abstract)*

Several frameworks and tools have been developed as simplified approaches to such complex analysis of social, ecological, and economic factors of

products and services, allowing the engineers and designers to make informed decisions regarding the products impact.

The life cycle Assessment (LCA) is one of the methods used by many companies, which allows the assessment of different types of impacts of products across their full life cycle.

The next section introduces the life cycle assessment in detail as well as its relevance to this study.

3.1.7 LCA

The life cycle assessment is an objective process to evaluate the socio-environmental burdens associated with a product, process, or activity. It identifies and quantifies energy and material usage and environmental releases, to assess their impact on the environment and the communities there are directly or indirectly related to it. The assessment includes the entire life cycle manufacturing, transportation, and distribution; use/re-use/maintenance; recycling; and final disposal. Moreover, the LCA seeks to identify and quantify each of the aspects within these phases. Finally, it evaluates and recommends improvement as to end or minimise socio-environmental impacts.

The LCA allows designers and other professionals to make knowledgeable decisions on where the most impacts are and what design strategies need to be developed to address such impacts. In order to make such complex analysis feasible, there is an extensive collection of Industrial Design tools available, along with LCA tools, ranging from inexpensive online ones to the more complex Design tools used by larger organisations. This project seeks to

investigate into the current tools being used on product development stages on the packaging industry in Singapore. Moreover, this project proposes an analysis of such strategies within the Singapore scenario regarding sustainable development policies and practices, as to facilitate the future development of customised methods and tools for the industrial sector in question. Figure 5 below illustrates a general product life-cycle.

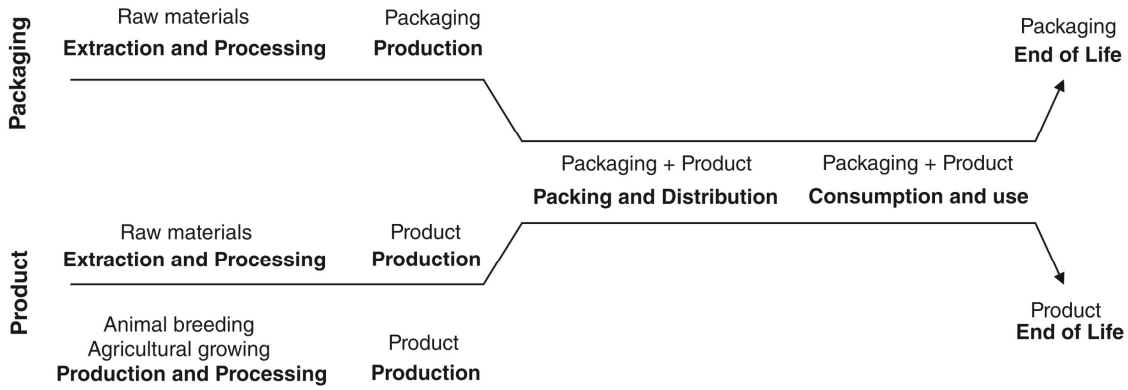

Figure 5. General product + packaging Life-cycle, adapted from Heller and Keoleian (2003).

The next section finalises the literature review chapter by giving an overview of Singapore in the context of sustainable development. Additionally, it introduces the packaging industry of Singapore as a potential framework for the development of this study.

3.2 Singapore and sustainable development

The relation between sustainable development and Industrial Design is the main focus of this research project. In order to facilitate the analysis of such broad concepts, this study proposes the investigation of their interaction within

a more specific context namely, the packaging industry in Singapore. This section gives an overview of Singapore regarding sustainable development and introduces its packaging industry as the most suitable framework for the development of this study.

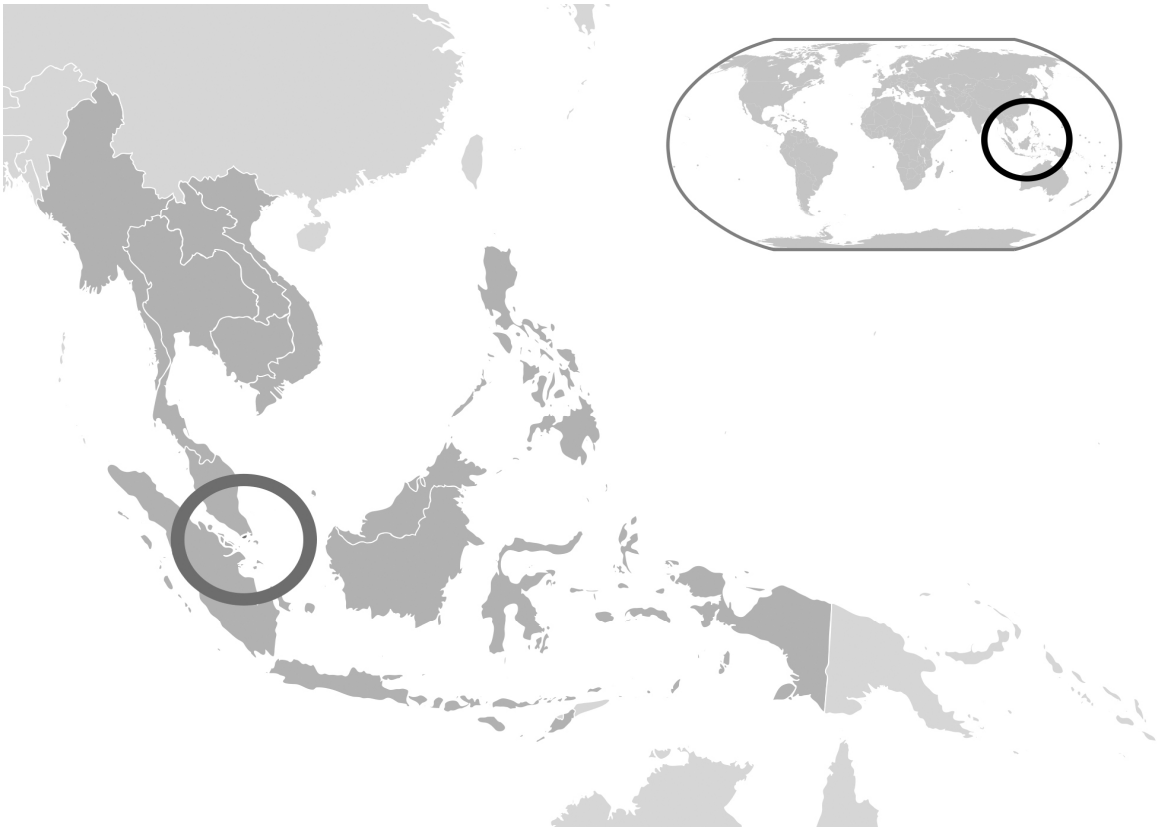

Figure 6. Singapore localisation

3.2.1 Singapore and its sustainable development Program

The sustainable development program is one of the government's plans for the continuous development of the country. It was created in January 2008 to formulate a national strategy for Singapore's sustainable development regarding domestic and global challenges. According to the program's guidelines, sustainable development means growing the city in a way that is

efficient (with less resources and waste), clean (without polluting our environment) and green (preserving greenery, waterways and our natural heritage). (URA, 2008)

> *"I want to develop Singapore in a sustainable way so that future generations of Singaporeans can also enjoy both economic growth and a good living environment. If I grow our city state in an efficient, clean and green way, and if each one of us is more environmentally conscious in the way I live, work, play and commute, I will all contribute our part to protecting the global environment." (URA, 2008)*

The Singapore sustainable development program along with the Singapore Business Federation in collaboration with the National Environment Agency (NEA) as well as other business and industry partners, is responsible for several initiatives to support and assist businesses and corporations in Singapore. The Industry's Directory is one of these initiatives. Released annually, "it provides a platform that companies can use to build awareness and recognition of their related products and services, enlarging existing networks and encouraging new collaborations". (SBFID, 2010)

Singapore comes as a unique scenario for the development of this research project; as it allows the observation and analysis of the Industrial Design responses to some of the Government's programs regarding sustainable development in its early stages. One of these programs was identified as a possible framework for the development of this study. The following section describes the government's solutions to Singapore's limited land regarding solid waste management.

3.2.2 Solid waste management and limited land

The Packaging industry of Singapore comes as an exceptional industrial sector in regard to this context. On account of the growing amount of waste in Singapore and its limited land, the government has developed a special plan for solid waste management, investing in different alternatives in the past few decades. One example is the construction of new incineration plants which are responsible for 90% reduction of the total incinerable waste that is daily generated in the island. In the past few years, recycling programs have also been implemented by The National Environment Agency to facilitate the recycling of some of the waste. However, incinerating and recycling only deals with waste that has been already generated. The total waste disposed in Singapore has increased by 6 fold since 1970 reaching 7,000 tons a day in 2006. Therefore, the government has launched a special program which seeks to reduce domestic waste at its source.

3.2.3 The Singapore Packaging Agreement

The Singapore Packaging Agreement was launched on July 2007, providing a platform and structure (pre determined strategies and goals) for industries to work together with the government in order to reduce packaging waste over a 5-year period. The Agreement is voluntary, allowing flexibility for the industries to develop and apply their own strategies for more cost-effective packaging solutions and therefore to reduce waste.

> *"Domestic waste formed 58% of all waste disposed of at the disposal sites in Singapore in 2009. Of this, about one third was packaging*

waste…food and beverage packaging waste constitutes more than 50% of household packaging waste." (SPAR, 2010)

This initiative was identified as a potential framework for the development of this research project as it brings the government of Singapore and the packaging industry together towards waste reduction, a goal which is directly related to socio-economic and environmental issues.

The 3R Packaging Award

The Singaporean Packaging Agreement, as previously mentioned, is one of the government's initiatives to reduce waste. It is also responsible for the development of the 3R Packaging Award. Its first edition took place on 2008, approximately a year after the agreement was first introduced. This award was created to recognise the participant companies for their efforts to reduce packaging waste.

"The 3R Packaging Awards have been developed to give recognition to signatories who have made notable achievements and contributions award the goals of the Singapore Packaging Agreement."

3R Packaging Awards 2008 Communication Folder

The Singapore Star Award

The Asia Star Awards are organised annually by the Asian Packaging Federation. The Singapore Packaging Star Awards event has been hosted by the Packaging Council of Singapore since 1998 giving special recognition to the Singaporean companies in several categories. (SCA Website, 2010)

“The Singapore Packaging Star Award recognizes and rewards excellence in packaging, in different categories such as construction and materials usage, design and innovation technology.”

An environmentally sustainable packaging category was first introduced in 2007 (Singapore Packaging Council Website). This is the category I am especially interested in.

4 RESEARCH SCOPE AND LIMITATIONS

The methodology section presented two possible approaches for the development of this study. The first approach proposed the study and subsequent comparison between Singapore based industries that have Eco-design strategies and industries that do not have Eco-design strategies. The second approach proposed the study and comparison among multinationals and local companies in Singapore in order to identify specific strategies within each context, and later establish a comparison between them.

Nevertheless, a closer look into the context of the packaging industry of Singapore showed that a considerable amount of companies have already developed some sort of strategy regarding sustainable development. In addition, most of them are already involved in the Singaporean government Packaging Agreement. Moreover, 31 of the companies from this sector have been awarded one of the two most relevant Packaging awards in Singapore in the past three years (2008, 2009 and 2010), namely, the 3R Packaging award and the Singapore Star award.

Therefore the second approach proposed in the methodology section (see figure 4) was selected. This approach allows an interesting comparison as there are many multinational packaging companies in Singapore that have already experienced the process of developing more sustainable products in the European context, in contrast to local Singaporean companies that have just started dealing with the situation.

Another important parameter for the case study development is the selected tool to analyse the proposed approach. The industrial production of packaging in Singapore is a complex activity that demands an appropriate perspective so as to be able to consider all the significant factors implicated.

The life cycle assessment was selected for the purpose of this study as it allows a deep and diversified analysis of the industrial activity discussed here.

> *LCA is one of the most rigorous and frequently used tools, with the objective of evaluating impacts of materials and products from the "cradle" (resource extraction), through transport, production, and use, to the "grave" (fate after end use). (Ny et al. 2006)*

The figure 5 shows a general product life cycle. It considers the "Packaging + Product" system; showing how complex it would be if all possible variables of each phase were considered. Heller and Keoleian (2003) have published several papers where they analyse the Sustainability Indicators of the U.S. Food System. The study is based on a life cycle Assessment regarding the system showed in figure 5.

Their study shows that 32.8% of all energy inputs for producing a single 455g can of sweet corn come from the *packaging* alone; followed by *food preparation* (14.9%) and agricultural *production* (14.7%), (Heller and Keoleian, 2000). In the same study, they show that on average the *packaging* represents only 7.7% of the energy input, while *food preparation* stands for 36.7% and agricultural *production* 23.0%. These results show the importance of selecting the relevant parts of the system to be considered while performing an LCA, since the

impacts' evaluation could differ significantly. Moreover, it reassures the importance of a systemic thinking when dealing with LCA.

In this study, only the first part of the system described above is considered. Since I am analysing 31 different companies that produce a variety of products, and the focus of this study is the design strategies that relate to the packaging production; the following system and life cycle phases are considered:

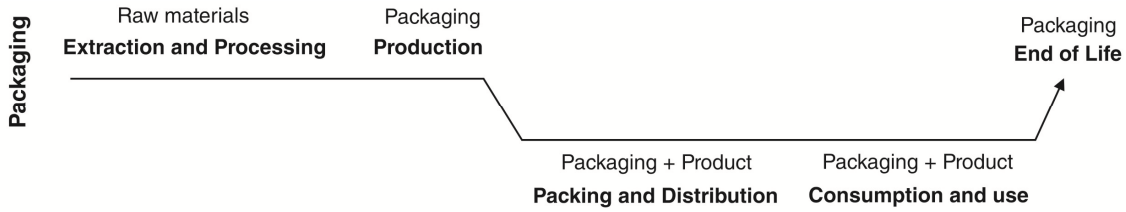

Figure 7. Case study scope product Life-cycle. Adapted from Heller and Keoleian (2003)

5 THE CASE STUDY - Data Collection Protocol

Three complementary types of data collection were developed in order to enable a broader analysis of the subject: companies' interview, a checklist and a survey.

First, six companies are analysed through a questionnaire. Secondly, 31 companies are analysed through a checklist developed especially for this study. Finally, the consumers of two shops specialised in eco-products in Singapore are assessed through a survey that took place in each of the stores for 2 months.

5.1 Companies' Interview

The 31 companies selected for the case study have different profiles ranging from small local companies to worldwide well known multinationals. Nineteen companies, the 3R Packaging Award winners of the past three years (2008, 2009 and 2010) were selected to participate in this case study.

Twelve companies, the star award winners of the past three years (2008, 2009 and 2010) in this category were selected to participate in this case study.

According to the Merriam Webster dictionary, a company which has *"divisions in more than two countries"* can be considered as a Multinational. In line with this definition 58% of the selected companies are Multinational companies while 42% are local Singaporean companies.

Thirty one companies were invited to participate. In line with the selected methodology, the first six companies that agreed to collaborate (three multinationals and three local companies) were visited and interviewed according to previously established questions.

The interview is composed of 15 questions covering several subjects on the companies' knowledge about sustainable development to its implementation and integration within the company and among its employees and community.

5. 2 Checklist

A checklist was developed to assist the evaluation of the award winning companies previously selected for this study. In total 31 companies were analysed through 33 questions, which are proposed in accordance with several checklists previously elaborated in the field, for the development of different sustainable products and services (Dangelico & Pontradolfo, 2010; Kurk & McNamara, 2006; MaxIll & van der Vorst, 2003; MaxIll & van der Vorst, 2006). Different phases of the product lifecycle were considered as well as the three main aspects directly related to sustainable development: environmental, economic and social aspects.

The list bellow shows the 31 companies analysed:

Asia Pacific Breweries

Boncafe International

Kentucky Fried Chicken

Tetra Pack Jurong

Chinatown Food Corp.

F&N Coca-Cola

McDonald's Restaurants

Nestle Singapore

Subway Singapore Dev.

Sunfresh Singapore

Hock Lian Huat

Microwave Packaging

Singapore Food Industry

Wyeth Nutritionals

YHS

Winrigo

IKANO

Universal Integrated Corp.

Ha Li Fa

People Bee Hoon Factory

Starbucks Coffee

Starlite Printers

Thong Siek Food Industry

Crown Beverage Cans

SCA Packaging Singapore

Salpac

Grenidea

Jebsen & Jessen

Reflex Packaging

Greenpac

Int. Paper Packaging

The information used to answer each of the questions was obtained from the companies' Websites as well as from the awards publications and interviews (in the case of the 6 company's interviews). The questions basically concern the implementation of several possible actions to minimise environmental and social impacts of the products during their whole lifecycle, taking into account local and global communities. Since the companies were not the ones directly answering the questions there is no answer such as "no" but rather blank spaces meaning that no information was found.

5. 3 Survey

The need to learn more about the Singaporean consumer's attitude towards Eco-friendly products is the main motivation for conducting this survey. Based on different previous studies on environmentally friendly consumer behaviour (Hassan (2010); Minton and Rose (1997); Roberts (2000)), it comprises six multiple choice questions that allowed the development of a profile regarding environmentally friendly consumers of Singapore. The profile includes gender, age group, and behaviour towards recycling initiatives, among other indicators.

The most relevant stores in Singapore regarding the commercialisation of Eco-friendly products were invited to participate. Two stores, 'CHOOSE. by Olive Ventures' and 'Simply Living', have agreed to collaborate by letting me conduct the survey in the store for two months, from February 15th to April 15th 2011.

In both stores, a brief explanation of the research project and the survey itself were nicely positioned close to the cashier, in an accessible place, motivating

the consumers' participation. Their collaboration was voluntary and the stores' were instructed to answer a few questions about the project as well as to assist the consumers in case they need help.

Simply Living

The Simply Living shop started in September 2009 by providing eco-design products to Singapore through their Website. The store was first opened in June 2010 in River Valley Road. According to the store Website, the shop was created to market handmade and fair trade products, in an attempt to 'help expand the opportunity for impoverished communities in developing countries to improve their economic independence.' The shop commercialises approximately 300 products ranging from organic chocolate bars, which costs 2.90 SGD, to recycled teakwood table, which costs 1299.00 SGD. According to Barbara Cooke, one of the owners of the shop:

> *"I originally started the business to promote awareness of fair trade products made by social enterprises in poor and marginalised communities. As many of these products are also sustainably designed, I began to grow the eco part of our business. I wanted to provide consumers with more eco and ethical choices while helping to raise awareness of the need to be more conscious as consumers."*

CHOOSE. by Olive Ventures

CHOOSE by Olive Ventures eco-store first opened in Chinatown, Singapore in July 2009. The shop commercialises over 200 eco-products ranging from newspaper pens which are made of old newspaper, as opposed to plastic, thus reducing plastic content by 50% and costing SGD0.80 each to personal energy monitors to help people track their energy use at home which costs SGD329.00.

Besides marketing environmentally friendly products the store also provides services such as bicycle parking, freecycle advertising and collection of recyclables, e-waste and printer toners and cartridges. They also host talks, courses "and workshops for people interested in anything to do with environmental sustainability.'

According to James Low Yiqi, one of the shop owners:

> *"Stuart and I were both very interested in climate solutions - green tech, environmentally friendly products, sustainability consultation - and I found that there was a dire lack of supply of these products in the region. Also, I felt that through the private sector, I could do reach out to businesses and consumers directly, thus providing education as much as possible."*

6 THE CASE STUDY - Findings

This chapter presents a description of the case study findings. A questionnaire was developed to interview the six companies selected according to the criteria discussed in the last section. Then, to better contextualise these six companies within the packaging industry in Singapore, a checklist was developed so as to enable a comparison among the most relevant aspects here discussed. Finally, the consumers of two eco-shops in Singapore were surveyed for two months, allowing me to also compare the consumers' preferences and the companies' current strategies in our final analysis. A more detailed description of these three sources of data is presented below.

This section is to present the research findings that arose from the data collection previously described.

6.1 Interview

The subsequent sections show a description on the findings from the companies' interviews. There are 6 case reports which are divided into two sections. First the company's background is presented followed by a summary of the company's answers to the questionnaire, providing information about how the company understand the concept of sustainability and how it is integrated within the company's daily activities. Later, some of the key questions of the questionnaire are presented in figures enabling us to better compare each of the company's answers. These figures illustrate the importance of the sustainability aspects discussed here for each of the

companies, as well as their implementation and integration within the company and among its employees and community.

The source of all information presented in this chapter, including the quotes, come either from the companies' Website and publications or from the interviews that were conducted specifically for this project. They are not highlighted here as it was agreed with the companies that their names would not be directly mentioned. However, all the sources used are properly cited in the references section. For the same reason, I have numbered and classified them in two groups. The three local companies will be referred to as LC01, LC02 and LC03 and the three multinationals will be referred to as MnC01, MnC02 and MnC03.

6.1.1 LC01

COMPANY BACKGROUND

Established in 1993, the company has nowadays two brands that commercialise more than 50 different food products for local and international markets. The products include fish balls, fish cakes, frozen seafood, and sausages among others. The company was awarded 3R Packaging Award in 2009.

INTERVIEW SUMMARY

How does the company understand the concept of 'sustainable development'?

The companies' understanding of 'sustainable development' acknowledges the relevance of environmental and economic aspects but socio-cultural aspects have not been clearly considered.

The company's strategies for sustainable development

LC01 has always worked towards packaging material minimisation and has recently joined the 'Singapore Packaging Agreement'. The company also encourages the use of email rather than paper mail to reduce paper waste. In addition, the set up of a recyclable collection area as well as a reading area with information on recycling are considered by the company as important environmental programmes[1]. These initiatives, together with the '3R Packaging Award' received by the company in 2010 can be seen as evidence of the company's acknowledgement of the importance of developing strategies for sustainable development. However, LC01 also recognises to be in its early stages of development regarding sustainable development strategies, *'having still lots to be improved'.*[2]

The replacement of plastic bags with reusable plastic containers was the measure that was chosen by the company to illustrate such initiatives. The plastic bags were used to hold products for weighing during the packing process, and they were not re-used so as to ensure the food products' quality. In 2009, the company has introduced reusable plastic containers replacing the

[1] Company's Interview
[2] Company's Interview

use of plastic bags. This initiative aims to “reduce plastic waste by 1.47 tons per year, with annual savings of more than $4,500”. [3]

The company’s development process of a product

The supply chain is not especially taken into account during the products’ development process and there is no life cycle approach taken into consideration thus far. However the company recognises the importance of these strategies and is working in the direction of implementing actions that enhance their performance towards sustainable development.

There are no Industrial Designers directly involved in the development process of new packaging within the company. The packaging is usually independently developed by subcontractors who are not directly involved in the company’s decision making process.

The company’s initiatives are not especially communicated employees or consumers as they believe they “can see the changes for themselves”. [4]

6.1.2 LC02

COMPANY BACKGROUND

Established in September 2002, LC02 is a Singapore based company specialising in designing and producing industrial packaging in line with customers’ specifications. According to the company Website their main goal is to provide

[3] 3R Packaging Awards 2010 folder
[4] Company’s Interview

"…innovative, holistic solutions for more efficient and environmentally friendly packaging to achieve bottom-line savings". [5]

The company has been awarded the Singapore packaging star awards for three consecutive years (2008, 2009 and 2010) in the environmentally sustainable packaging category.

INTERVIEW SUMMARY

How does the company understand the concept of 'sustainable development'?

The companies' understanding of 'sustainable development' acknowledges the relevance of environmental aspects as an integrated factor to the company's day-to-day activities and its strategic planning. However, but economic and socio-cultural aspects have not been clearly considered.

The company has a variety of environmentally friendly packaging materials available through selected suppliers. They believe this is a differential while helping their customers design the required packaging as it assists them on making it reusable, returnable, and recyclable and therefore reducing waste.

"Sustainability to us is reusing waste, making sure that the packaging can be reused many times; contributing to the environment."[6]

5 Company's website
6 Company's Interview

The company's strategies for sustainable development

According to the company (and its own definition of 'sustainable development'), 100% the products being currently commercialised are environmentally friendly. Although economic and socio-cultural aspects have not been particularly considered, it is important to highlight the fact that the company claims to follow strict health and safety guidelines and only non-toxic materials are used. One of the products that were chosen by the company to illustrate such initiatives consists of a returnable and collapsible OSB (oriented strand board) container. This product is also reusable, easy to disassemble and maintain. It is mounted and dismounted by interlocking only; no toxic glue or needles are used,[7] and it is made of FSC -certified wood. According to the Forest Stewardship Council, FSC certified forest products are verified from the forest of origin through the supply chain. The FSC label ensures that the forest products used are from responsibly harvested and verified sources. Moreover, according to the company: *"customers like it because it saves money"*[8].

The company's development process of a product

The supply chain is taken into account especially through the selection of suppliers and strategic partners. *"They are required to be certified, and also require their suppliers to be certified."*[9]

A life cycle approach is also taken into consideration. Besides cautiously selecting their suppliers, they carefully select the materials to be used in each

[7] Company's Interview
[8] Company's Interview
[9] Company's Interview

project, also making sure that, when feasible, the product is returnable, collapsible, and can be disassembled, always using the smallest amount of material as possible. Moreover, although recycling is out of their boundaries, the materials used are recyclable. There is no software or specific tools used. Calculations are based on estimation.

There are no Industrial Designers directly involved in the products' development process. The company's team responsible for designing and testing the products is composed mainly of engineers who work closely with their suppliers.

The company communicates these strategies by taking part in contests and awards as well as *'creating awareness in the market'* and participating in discussion meetings with other companies from the sector. Some of these meetings are organised by the Singapore Packaging Agreement which LC02 joined a few years ago. For the company these meetings are great opportunities to collaborate and learn from other companies' experiences.

6.1.3 LC03

COMPANY BACKGROUND

Established in 2001, LC03 is a Singapore based company specialised in designing and manufacturing cardboard food and beverage containers. According to the company's owner, it focuses on user-friendly, eco-friendly, and advanced microwave cooking technologies among other features in order *'to*

provide innovative functionalities to their customers[10]*.* The company has been awarded 3R Packaging Award in 2009.

INTERVIEW SUMMARY

How does the company understand the concept of 'sustainable development'?

The companies' understanding of 'sustainable development' acknowledges the relevance of environmental aspects as an integrated factor to the company's day-to-day activities and its strategic planning. However, economic and socio-cultural aspects have not been clearly considered.

According to the company they look more into '*renewability'* than *sustainability:*

"Sustainability to us is to be continuously able to renew itself."[11]

"…anything that you use and throw away is never sustainable. Something that you can grow and continue to rebirth; that is sustainability"[12]

The company's strategies for sustainable development

According to the company (and its own definition of 'sustainable development'), 100% of the products being currently commercialised can be classified as sustainable products.

[10] Company's Interview
[11] Company's Interview
[12] Company's Interview

One of the products that were chosen by the company to illustrate such initiatives consists of a container for takeaway food made of recyclable FSC certified paper (see Forest Stewardship Council).

> *"We are making paper packaging, and I think we are the only company here in Singapore who is making food containers out of FSC certified paper. And I only use plastic when I cannot avoid it."*[13]

The containers' trapezium shape keeps the food warm for longer. In addition, the Pack, as it is designed with pin-hole pressure release valves to release excessive pressure, thus preventing continuous cooking inside the box; promising to preserve food's taste and texture.[14]

In order to minimise packaging material and waste, the company has also invested in redesigning their packaging by reducing the amount of raw paper material used. The thickness of the boxes was reduced to 33gsm, and by changing the manner in which the boxes were cut 8% less paper is now used to make the same amount of boxes. Moreover, 20% of the company's clients have switched to the new packaging and LC03 estimates that up to 108 tons/year of paper could be potentially saved. [15]

The company's development process of a product

"Customers would pay for the branding but not for innovative eco-friendly products"[16]

[13] Company's Interview
[14] Company's Interview
[15] 3R Packaging Awards 2009 folder
[16] Company's Interview

"It took me a total of 5 years to fully develop the design and the machine to manufacture before finally bringing my first invention to market. This microwavable food pack offers far more than any ordinary food container."[17]

The supply chain is taken into account especially through the selection of suppliers *"100% of our paper material is FSC certified paper."*[18]

A life cycle approach is also taken into consideration. Besides cautiously selecting their suppliers, they carefully select the materials to be used in each project, also making sure that, when feasible the product can be recycled, always using the smallest amount of material as possible. There is no software or specific tools used. Calculations are made by 'observation and experience'.

There are no Industrial Designers or engineers directly involved in the products' development process. The company's Managing Director is responsible for designing and testing all the products. With no specific background, he works mainly by '*observation and experience.'*

The company does not especially communicate these initiatives to their clients. Although a lot of information illustrating how environmentally friendly they intend to make their product can be found on the Website, not much effort is put into it.

"Frankly speaking the 'environmentally friendly' is the last of our speech. Everybody knows it is environmentally friendly. But this is the least they

[17] Company's Interview
[18] Company's Interview

are concerned when they are going to buy… when it comes to pay they say: 'which is the cheaper one?'"[19]

The company does print environmental awareness information on the side of the boxes, in order to educate Singaporean citizens towards environmentally friendly attitudes. They also allow other companies to print advertisements on the boxes. The idea behind this initiative is to drive more users to have access to an environmentally friendly packaging. The companies that pay to have their advertisements printed on the boxes subsidise the packaging cost to the final consumers. LC03 is then able to sell the containers to the food centres in Singapore for 20% of the original price; making it more advantageous for them to replace non eco-friendly packaging with eco-friendly ones.

6.1.4 MnC01

COMPANY BACKGROUND

Founded in Germany at the end of the 19th century MnC01 was first established in Singapore and Malaysia in 1963. A diversified business enterprise engaged in seven core businesses, packaging being one of them, it provides industrial packaging solutions across South East Asia and other countries, offering *"customised solutions that achieve optimal productivity and cost efficiency"*[20] . The company has been awarded the Singapore packaging star awards in the environmentally sustainable packaging in 2008 and 2010.

[19] Company's Interview
[20] Company's Website

INTERVIEW SUMMARY

How does the company understand the concept of 'sustainable development'?

The companies' understanding of 'sustainable development' acknowledges the relevance of economic aspects highlighting the idea that the company should be able to economically sustain itself. Environmental and socio-cultural aspects have not been clearly considered and do not seem to be integrated parts of the company's day-to-day activities and its strategic planning.

The company's strategies for sustainable development

According to the company (and its own definition of 'sustainable development'), there is no specific development of products that contemplate environmental or socio-cultural aspects; since the development of sustainable products depends entirely on clients' demand.

"Strategies regarding sustainability aspects are 100% customer driven"[21]

In this context, some of their clients, usually multinationals which already have a strict sustainability program, play a significant role in engaging MnC01 into strategies towards more sustainable products. These companies would, for example, require that MnC01 provides a choice environmentally friendly and certified materials; thus, pushing them to be in compliance with certain supplier standards. For instance all the paper pulp used is 100% recycled FCS certified material (see Forest Stewardship Council).

[21] Company's Interview

Moreover, 35% of all construction foam used is recycled by the company itself since "*all the material that is processed in the company is internally recycled*"[22], not only reducing the cost but also considerably minimising raw material wastage.

The product that was chosen by the company to illustrate such initiatives consists of a paper based packaging design that protects and stores three different products into one packaging.

> *"Besides reducing packaging and inventory costs, the packaging is made from biodegradable and environmentally friendly materials."*[23]

The company's development process of a product

The supply chain is taken into account especially for those companies which comply with certain supplier standards.

A life cycle approach is not considered. There are also no software or specific tools used. Calculations are made by the engineers.

There are no Industrial Designers directly involved in the process. The company's team responsible for designing the products is composed mainly by mechanical engineers that work in collaboration with their suppliers.

The company does not especially communicate these initiatives to their clients.

[22] Company's Interview
[23] Company's Interview

6.1.5 MnC02

COMPANY BACKGROUND

MnC02 is an Asian brewery company which was established in Singapore (Malaya at the time) in 1931. It currently sells over 120 brands of beer and beer variants, controlling 30 breweries in 12 countries in the Asia Pacific region. The company has been awarded the Singapore packaging star awards for three consecutive years (2008, 2009 and 2010).

INTERVIEW SUMMARY

How does the company understand the concept of 'sustainable development'?

> *"100%. Sustainability is absolutely integrated into what I do. And it has been for many years it is not something new for us."*[24]

The companies' understanding of 'sustainable development' acknowledges the relevance of environmental, socio-cultural, and economic aspects as integrated parts of the company's day-to-day activities and its strategic planning.

> *"I regard it as our licence to operate, if I don't operate in a sustainable way then our business will not continue, at some point it would become an untenable business so I take it extremely seriously because of the environmental aspect of the production, I am very aware of it, there is also the sociological side of our product which I am also very aware of.*

[24] Company's Interview

So, I understand that these two things, I have to run our business in a way that it fits in with society and I am still here in ten, thirty, fifty, a hundred years' time. That is the way I look at sustainability."[25]

The company's strategies for sustainable development

According to the company (and its own definition of 'sustainable development'), 100% of the products being currently commercialised contemplate environmental as well as socio-cultural aspects. One of the products that was chosen by the company to illustrate such initiatives consists of a returnable plastic container which replaced the one-way carton boxes that were used until 2009. This initiative would eliminate the waste of 1.6 tons of paper-packaging per year.[26]

The company has also invested in reducing their packaging thickness, for aluminium cans and glass bottles, being able to reduce 36 tons and 80 tons of packaging material respectively.

"In some cases it is reduce, in other cases it is reusable, returnable packaging that will last for many years, and also recycling. All internal waste produced is separated and sent for recycling: aluminium, paper and glass. I support recycling a 100%".[27]

[25] Company's Interview
[26] 3R Packaging Awards 2009 folder
[27] Company's Interview

The company's development process of a product

The supply chain is taken into account throughout the whole products' development by specialised professionals who work closely with the design team.

A life cycle approach is also taken into consideration. Besides cautiously selecting their suppliers, they carefully choose the materials to be used in each project, making sure that, when feasible the product can be recycled and/or returnable. Moreover, they always try to improve their production system in order to use the smallest amount of material as possible.

> *"It is estimated that at least 85% of the returnable bottles return to the manufacturing units. In addition, each returnable bottle completes, in average 20 cycles."*[28]

There is no software or specific tools used. Calculations are internally made relying on conservative assumptions.

There are no Industrial Designers directly involved in the process. The company's team responsible for designing the products is composed of engineers and packaging technologists in collaboration with their suppliers. They are responsible for creating and testing new products. Ideas for innovative solutions come from research, by openly sharing information with other companies and from the suppliers with whom they work closely with.

[28] Company's Interview

The company does not especially communicate these initiatives to their clients or stakeholders. However they recognise the importance of doing so and intend to start developing means to communicate it from 2011 onwards.

6.1.6 MnC03

COMPANY BACKGROUND

MnC03 is a multinational food processing and packaging company which was founded in Sweden in 1951. Established in Southeast Asia since 2007, the company's main offices in the region are situated in Singapore, Philippines and Malaysia. The company has been awarded the Singapore packaging star awards for three consecutive years (2008, 2009 and 2010).

> *"Our vast experience in food technology brings you guaranteed cost-efficient performance, trouble-free operation and environmentally friendly packaging solutions."*[29]

INTERVIEW SUMMARY

How does the company understand the concept of 'sustainable development'?

> *The companies' understanding of 'sustainable development' acknowledges the relevance of environmental, socio-cultural and*

[29] Company's Interview

economic aspects as integrated parts of the company's day-to-day activities and its strategic planning.

"I must not degrade nature by using resources faster than nature can replace them – for example I must ensure that the rate at which I harvest trees is more than matched by the rate at which they are replaced. And, ensure that I sustain the diversity of the forests and the lives they contain."[30]

The company's strategies for sustainable development

According to the company (and its own definition of 'sustainable development'), all their products have similar platforms, contemplating environmental and socio-cultural aspects whenever possible.

"I believe that using material produced from forests, which are a renewable source, is definitely the most sustainable way of doing business. As well as providing positive points, renewability also offers an important competitive advantage since it is an environmental attribute that is valued by consumers and other interested parties."[31]

The measures that were chosen by the company to illustrate such initiatives consist of several changes in its production line to reduce packaging waste. For instance, by changing the production set up the company was able to *"reduce about 119 tons of paper and avoid losses of up to 144 tons of polyethylene polymer per year."*[32] In addition, the company has also invested in recovering

[30] Company's Interview
[31] Company's Interview
[32] 3R Packaging Awards 2009 folder

polyethylene by recycling the production waste internally, which enabled them to eliminate 380 tons of material loss per year. Moreover, MnC03 is recognised in Singapore by its recycling educational programs together with public schools and community centres.

The company's development process of a product

> *"… carton packaging plays an important role thanks to its low light and high filling accuracy. It is easy to pack and distribute and because of its strength it offers excellent protection at low cost. Products being filled and packed under aseptic conditions require no refrigeration, thus saving large amounts of energy in warehouses, transport and storage."*[33]
>
> *The products' life cycle is taken into account through the life cycle Assessments (LCAs) which assists the company on the analysis of the impact of packaging throughout the chain of supply and consumption. It enables us to make informed decisions to drive product development and innovation in sustainable direction."*[34]

Software and special tools are often used for LCAs and general calculations.

> *"Projects must take account of societal and environmental demands, consumer and customer requirements and our environmental strategy. I assign environmental targets to each project and make regular checks that the criteria are being addressed."*[35]

[33] Company's Interview
[34] Company's Interview
[35] Company's Interview

There are no Industrial Designers directly involved in the process. The company's Corporate Environmental Office supports the development teams which are responsible for designing the products. The team is composed of engineers who work in collaboration with their suppliers.

The company communicates these initiatives to their clients and stakeholders through publications and educational programs.

6.2 CHECKLIST

This section shows the results obtained from the checklist from two different angles. First, I show how the three aspects of sustainable development have being considered by the companies. Later, each of these aspects is detailed highlighting the companies approach according to the life cycle phases considered in the checklist.

6.2.1 The companies' strategies and the sustainable development aspects

The charts below summarise the checklist results. They show how the three aspects of sustainable development (economic, environmental and socio-cultural) have been considered during the products' development phases by the 31 companies analysed.

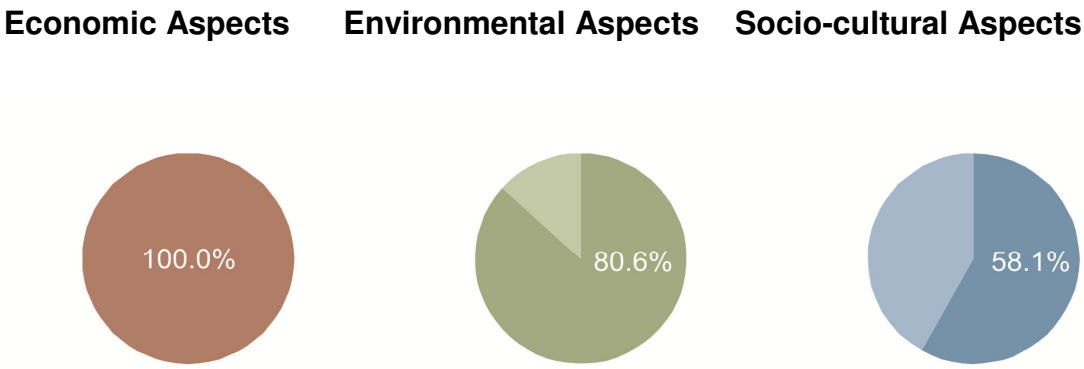

Figure 8. Checklist analysis 1 – Economic, Environmental and Socio-cultural Aspects

As can be seen, 100% of the companies have considered economic aspects while developing their products. 80.6% have also considered environmental aspects, while 58.1% have also considered socio-cultural aspects.

The checklist also allows us to take a closer look into the three aspects above by showing the companies' strategies in relation to each of the products' life cycle phases analysed.

The charts below (Economic, Environmental and Socio-cultural) show the three aspects considered in relation to each of the products' life cycle phases analysed:

- Raw materials extraction and processing
- Production and Assembly
- Distribution and Retail
- Consumption, use
- End of life

Economic aspects

100% of the companies claimed to have the production cost of their products reduced after some of the design strategies considered have been implemented. Therefore our priority in this study will be given to the environmental and socio-cultural aspects.

Environmental aspects

The chart below illustrates how the environmental aspects were considered in each of the life cycle phases analysed.

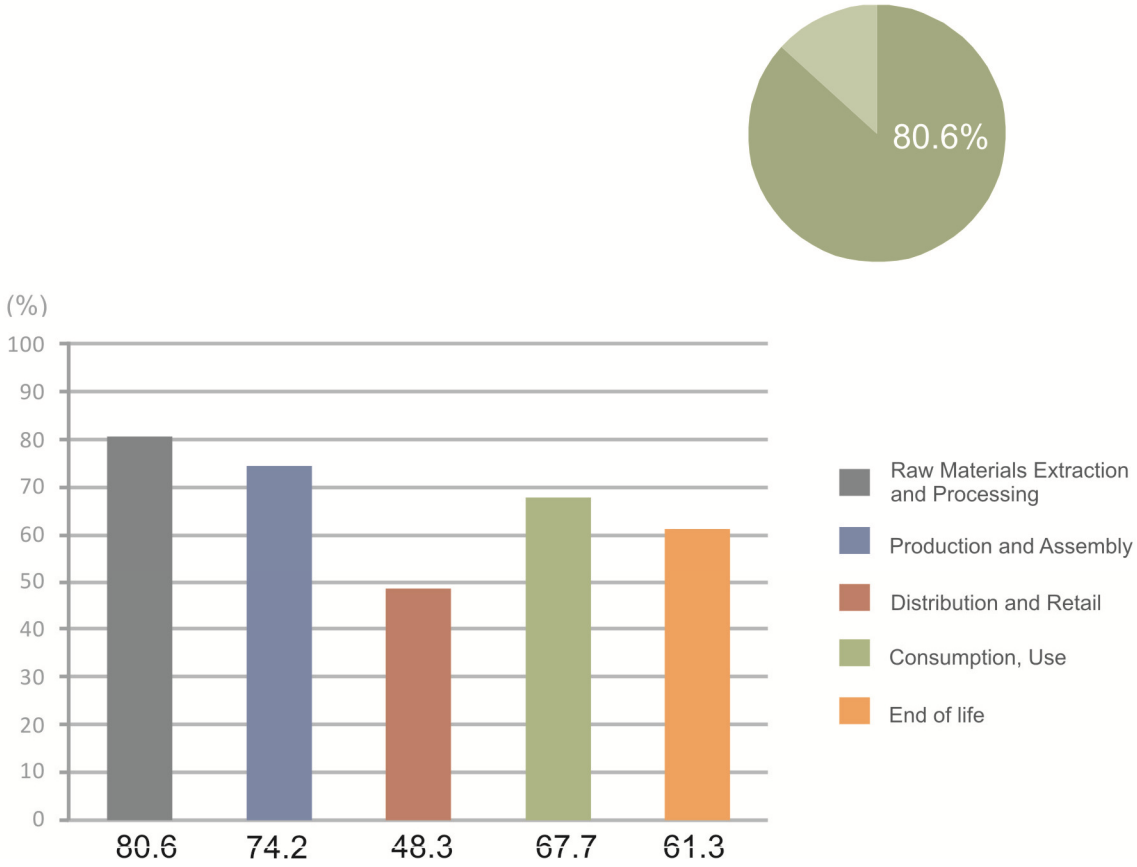

Figure 9. Checklist analysis 2 - Environmental Aspects

It shows that most of the companies analysed (80.6%) have prioritised the 'raw materials extraction and processing' phase while implementing Industrial Design strategies related to environmental aspects. 'Production and Assembly' was the second phase that was mostly considered by the companies (74.2%) when implementing design strategies regarding environmental aspects, followed by 'Consumption, use' (67.7%) and 'End of life' (61.3%) phases. The

chart also shows that ‘Distribution and Retail’ was the least prioritised phase, being considered by less than half of the companies (48.3%).

Socio-cultural aspects

The chart below illustrates how the Socio-cultural aspects were considered in each of the life cycle phases analysed.

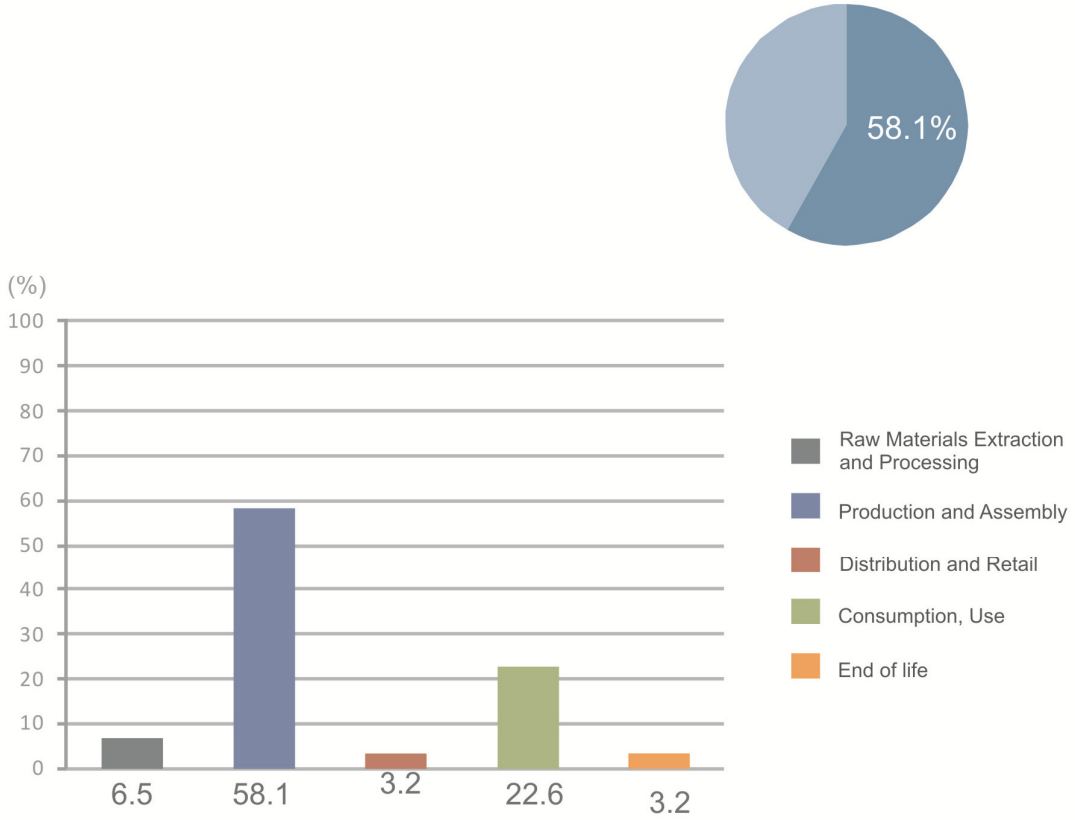

Figure 10. Checklist analysis 3 - Socio-cultural aspects

It shows that most of the companies analysed (58.1%) have prioritised the ‘Production and Assembly’ phase while implementing Industrial Design strategies related to socio-cultural aspects. ‘Consumption, use’ was the second phase that was mostly considered by the companies (22.6%) when implementing design strategies regarding socio-cultural aspects, followed by

the ‘Raw materials extraction and processing’ (6.5%) phase. The chart also shows that ‘Distribution and Retail’ and ‘End of life’ were the least prioritised phases, being considered by 3.2% of the companies.

6.2.2 The companies’ strategies and the life cycle phases

The checklist is composed of 33 questions covering economic, environmental and socio-cultural aspects in relation to each of the products’ life cycle phases analysed. Each of these questions corresponds to a specific strategy that could have been implemented by the companies.

Let us now take a closer look at the companies’ strategies by analysing each of the check list questions in relation to each of the life cycle phases. Each question corresponds to one strategy. The strategies being analysed as well as the percentage of companies that resorted to each of these strategies, referred to as active companies (AC) are presented below:

Design strategies by type of impact and Life cycle phase	AC (% of companies per strategy)
Environmental impacts	
Raw materials, Extraction and processing	
1. Is the amount of raw materials used in the products minimised?	77
2. Is the amount of restricted materials used in the products minimised or eliminated?	10
3. Is the amount of materials coming from certified suppliers maximised or totally achieved?	13
4. Is there implementation or optimisation of energy conservation practices during raw materials' extraction and processing phases?	0
Production, Manufacturing	
5. Is the number of types of materials used in the products minimised?	16
6. Is the amount of materials used in the products minimised during production phase?	68
6A. Reduction, elimination of components?	16
6B. Packaging weight?	65
7. Is the use of recycled and/or renewed materials implemented or optimised during production phase?	19
8. Is the production technology optimised in order to minimise, eliminate emissions to air, effluents, waste or energy use?	32
9. Is the company's internal waste recycled/reused within the company or sent to recycling/reuse?	19
Distribution	
9. Is the amount of materials used in the distribution of the products minimised?	29
10. Is the transport fuel and/or technology optimised in order to minimise, eliminate emissions to air and/or or energy use?	0
11. Are there alterations in the distribution packaging to improve case, palletisation, transport efficiency and/or reduce waste?	32
12. Are there alterations in the distribution packaging to make it reusable?	26

Table 1 (continued). Percentage of companies that resorted to each of the strategies studied I

Design strategies by type of impact and Life cycle phase	AC (% of companies per strategy)
Consumption, Use	
13. Are there products made for refill and/or reuse?	23
14. Are the products easily disassembled for discarding and or recycling?	61
15. Have potential barriers to recycling removed: use of additives, embedded metal threads in plastics, paint, multilayer material, use of materials of unknown composition and or difficult to separate?	19
16. Are there alterations in the product to reduce waste and/or energy use during consumption phase?	19
End of life	
17. Are the materials used in the products easy to identify by type and separate?	61
18. Are the products easily disassembled for reuse, recycling or composting at the end of its life?	58
19. Are the products developed in accordance with and/or to facilitate the local solid waste management system?	0
Social impacts	
Raw materials	
20. Is the company committed to maintaining a productive, healthy and safe environment for the employees during raw materials' extraction and processing phases?	0
21. Is the company committed to have only certified suppliers?	6
Production and Assembly	
22. Is the company committed to maintaining a productive, healthy and safe environment for its employees as well as its subcontract companies'?	3
23. Are the adverse health/safety impacts for the local community taken into account during the products' production phase?	3
24. Does the company promote environmental awareness among their employees?	19
25. Does the company promote environmental awareness among the community?	39
Distribution and Retail	
26. Are the adverse health/safety impacts for the global community taken into account during the products' distribution and retail phases?	3

Table 2 (continued). Percentage of companies that resorted to each of the strategies studied I

Design strategies by type of impact and Life cycle phase	AC (% of companies per strategy)
Consumption, Use	
27. Does the company promote environmental awareness during the products' use?	19
28. Are the adverse health/safety impacts for the local community taken into account during the products' consumption phase?	3
29. Are the adverse health/safety impacts for the global community taken into account during the products' consumption phase?	0
End of life	
30. Are the adverse health/safety impacts for the local community taken into account during the products' end of life?	6
31. Are the adverse health/safety impacts for the global community taken into account during the products' end of life?	6
Economic impacts	
32. Do the altered products cost less than the previous versions?	100
Decision making in all phases	
33. Does the company make use of software or other tools for guiding decision making regarding environmental and/or social impacts during product development phases?	6

Table 3 (concluded). Percentage of companies that resorted to each of the strategies studied I

The subsequent charts illustrate how often each of the strategies considered were implemented by the companies analysed in each of the life cycle phases considered in relation to Environmental and Socio-cultural aspects.

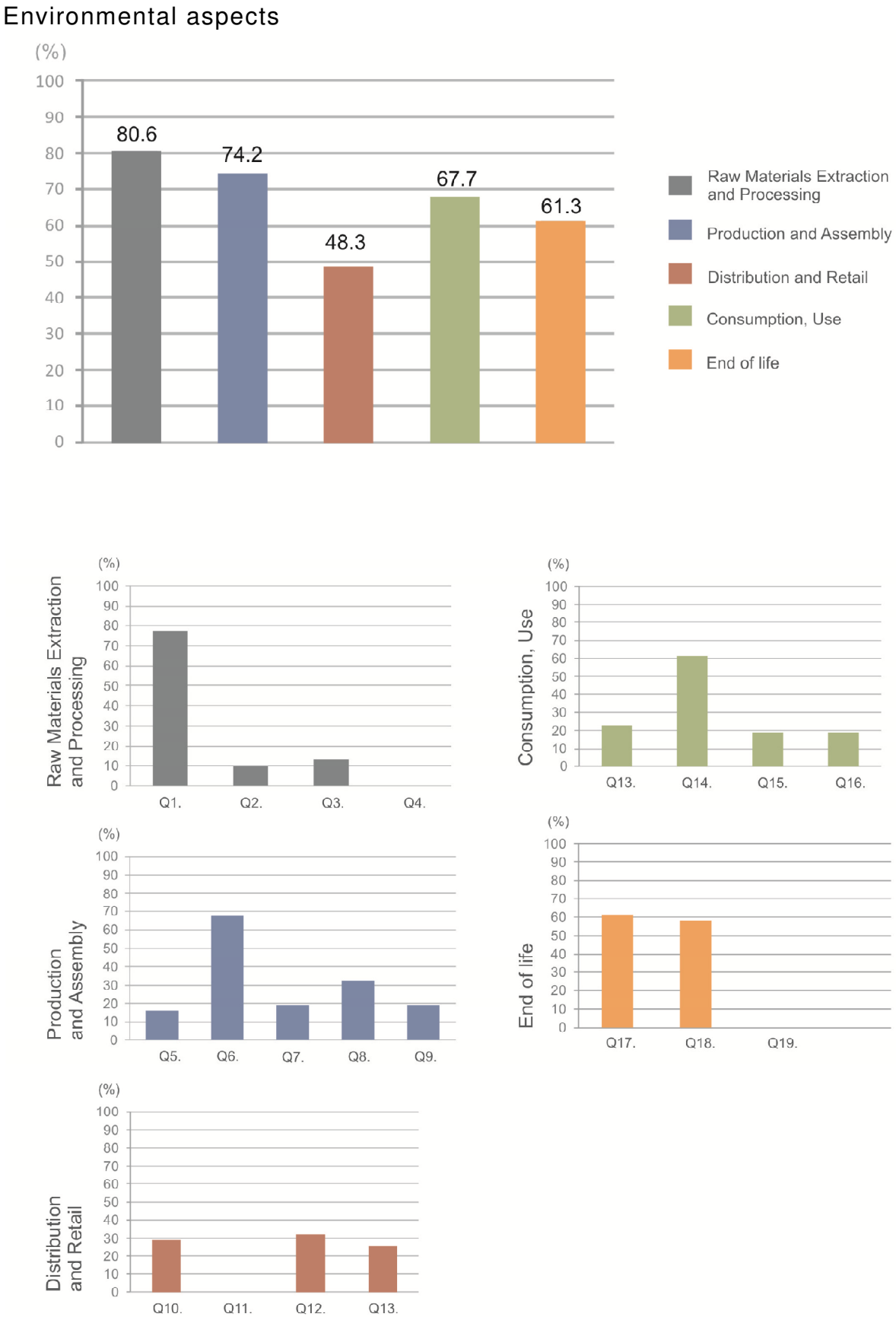

Figure 11. Illustration of the Checklist Environmental Aspects

The charts above illustrate the percentage of the companies that resort to each of the strategies analysed in each of the life cycle phases considered in relation to Environmental aspects.

As can be seen most of the companies analysed (80.6%) have prioritised the 'Raw materials extraction and Processing' phase while implementing Industrial Design strategies related to environmental aspects. However, a closer look at the 'Raw materials extraction and Processing' phase shows that the strategy associated with question number 01 (the minimisation of the amount of raw materials used in the products) was implemented by 77% of the companies.

Similarly, in the case of 'Production and Assembly', which was the second phase mostly considered by the companies (74.2%) when implementing design strategies regarding environmental aspects; the strategy linked to question number 06 was responsible for most of the implementations. 68% of the companies implemented strategies concerning the minimisation of the amount of materials used in the products during its production phase. The checklist also shows that 16% of these companies minimised the amount of material by reduction or eliminating components, and 65% did so by reducing the packaging weight.

'Distribution and Retail' was the least prioritised phase, being considered by less than half of the companies (48.3%). A closer look at this phase shows that apart from strategy regarding optimisation of transport fuel and/or technology in order to minimise or eliminate emissions to air and/or or energy use, which was not implemented by any company, the three other strategies (linked to questions 09, 11, and 12) were evenly considered. Approximately 30% of the

companies, implemented strategies regarding: the minimisation of the amount of materials used in the distribution phase; alterations in the distribution packaging to improve case, palletisation, transport efficiency and/or reduce waste; and alterations in the distribution packaging to make it reusable.

The 'Consumption, use' chart shows that from the 67.7% companies that implemented strategies in this phase, 61% invested in making products that are easily disassembled for discarding and or recycling. While approximately 20% invested in the following strategies: making products that facilitate refill and/or reuse; removing potential barriers to recycling and modifying the product to reduce waste and/or energy use during its consumption phase.

The 'End of life' phase was prioritised by 61.3% of the companies. A closer look at this phase shows that apart from strategy regarding the adequacy of the products developed to the local solid waste management system, which was not implemented by any company; the two other strategies (linked to questions 17 and 18) were evenly considered. Approximately 20% of the companies, implemented strategies regarding: the facilitation in the identification and separation of the types of materials used in the products as well as the products' dissemblance for reuse, recycling or composting at the end of its life.

Socio-cultural aspects

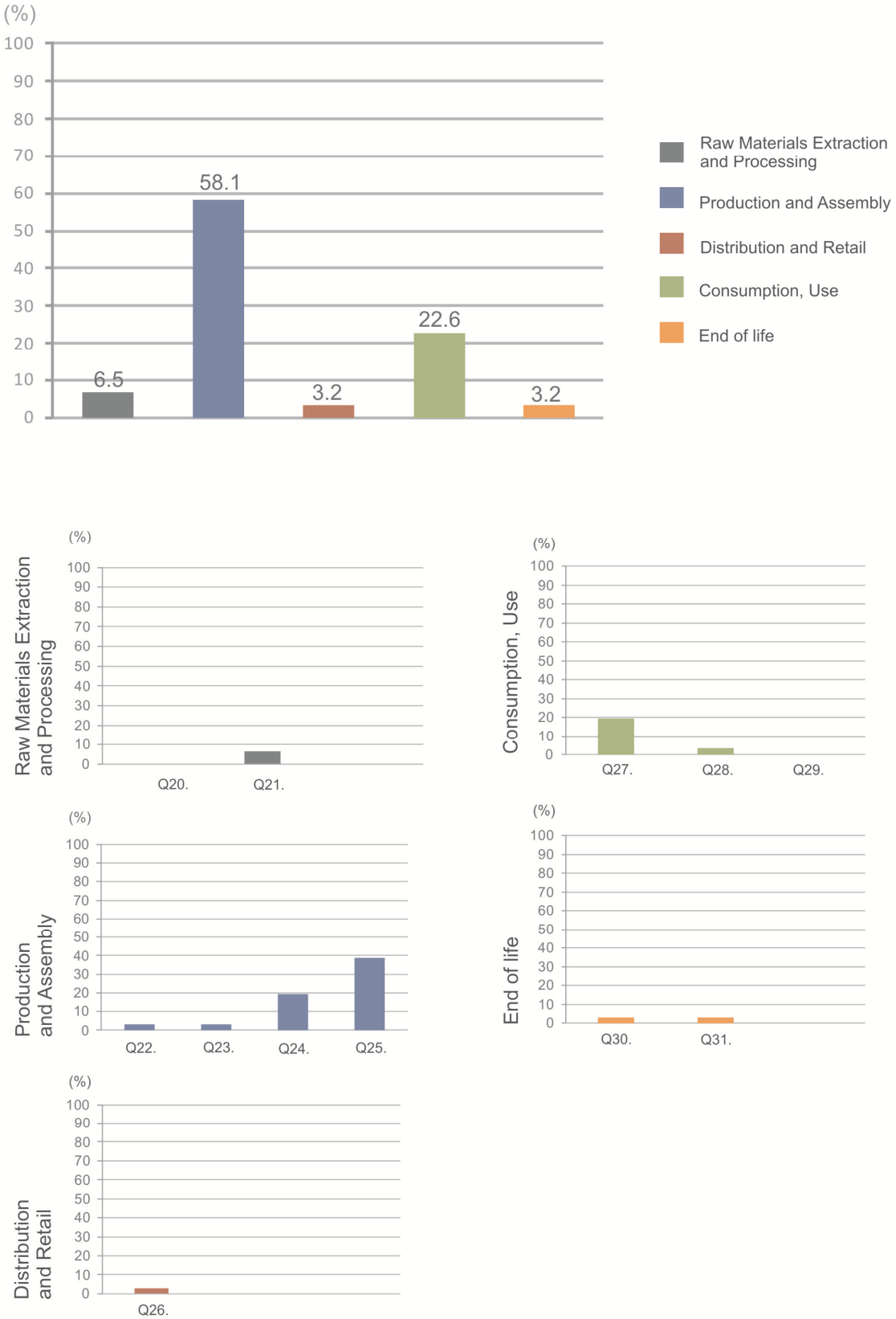

Figure 12. Illustration of the Checklist Socio-cultural Aspects

The charts above illustrate the percentage of the companies that resort to each of the strategies analysed in each of the life cycle phases considered in relation to socio-cultural aspects.

As can be seen most of the companies analysed (58.1%) have prioritised the 'Production and Assembly' phase while implementing Industrial Design strategies related to socio-cultural aspects. However, a closer look at the 'Production and Assembly' phase shows that the strategies associated with question numbers 24 and 25 were implemented by 19% and 39% respectively. Both strategies propose the promotion of environmental awareness among the companies, employees (Q24) or among local and global communities (Q25).

'Consumption, use' was the second phase that was mostly considered by the companies when implementing design strategies regarding socio-cultural aspects. However it was considered by less than half of the companies analysed (22.6%). This phase's chart shows that the strategy associated with questions number 27 (regarding the promotion of environmental awareness during the products' use) was implemented by 19% of the companies.

The chart also shows that adverse health/safety impacts for the local community during the products' consumption phase were only considered by 3% of the companies (Q28). In addition, none of the companies (0%) have shown special consideration to adverse health/safety impacts for the global community during the products' consumption phase (Q29).

The remaining three phases were considered by less than 7% of the companies. The 'Raw materials extraction and processing' phase was prioritised by 6.5%. However 100% of these initiatives were committed to the importance of having only certified suppliers (Q21), while none of these companies seemed to have implemented strategies regarding the maintenance of a productive, healthy and safe environment for the employees during raw materials' extraction and processing phases (Q20).

The chart also shows that 'Distribution and Retail' and 'End of life' were the least prioritised phases, being considered by 3.2% of the companies.

The 'Distribution and Retail' chart shows that 3.2% of the companies have taken adverse health/safety impacts for the global community into account during the products' distribution and retail phases (Q26). While the 'End of life' chart shows that strategies related to questions 30 and 31 were also considered by 3.2% of the companies. Such strategies contemplate the consideration of adverse health/safety impacts for local and global communities, respectively, during the products' end of life.

The 32nd question of the checklist is a general question regarding how the companies relate the strategies studied here with economic aspects. 100% of the companies analysed have claimed that the altered products' cost less than the previous versions.

The 33rd question of the checklist considers the use of softwares or other tools for guiding decision making regarding environmental and/or social impacts during product development phases. 6% of the companies analysed have declared use of softwares or other tools for guiding decision making.

6.3 Survey

This section describes the information obtained from the eco-store survey. In total 50 customers answered the survey. The information below is presented in terms of percentage.

The first data set (Figure 13) shows the data collected from both stores showing the answer to each of the questions proposed. The subsequent ones present the information from each of the stores separately, facilitating the latter comparison among them.

Products' Aspects	Importance from 1 to 6 (%)					
	1	2	3	4	5	6
1. Products made of natural ingredients	30.0	32.0	6.0	16.0	14.0	2.0
2. Products made of recyclable/recycled materials	0.0	24.0	34.0	16.0	10.0	6.0
3. Price	40.0	22.0	14.0	6.0	10.0	8.0
4. Products that allow energy saving	4.0	10.0	26.0	12.0	28.0	20.0
5. Fair trade Products	14.0	10.0	8.0	24.0	12.0	32.0
6. Products with less packaging material	2.0	2.0	12.0	26.0	26.0	32.0

choose+simplyliving

100% = 50

02. Do you collect/separate your household trash for recycling?

YES Why?

57.3% I believe it is important.

10.4% There is a collection system which makes it easy to do.

NO Why?

8.8% I don't believe it is important.

23.5% There is no collection system which makes it difficult to do.

03. How often do you talk to your friends, neighbours and relatives about environmentally friendly products and/or activities?

12.7% Always

46.5% Often

38.0% Rarely

2.8% Never

Participant information

Gender:

25.4% Male

74.6% Female

Age group:

12.7% below 20

46.5% 20 to 30

26.7% 30 to 40

14.1% above 40

Educational Level:

0.0% Below Secondary

7.0% Secondary

5.6% Post Secondary

15.6% Polytechnic - Other Diploma

71.8% University - Degree, Masters & Ph. D

Figure 13. Illustration of the data collected from the survey 1

In the first question of the survey, the participants were asked to rank in the order of importance to them what would be the relevance of the following products features: products made of natural ingredients; products made of recyclable/recycled materials; price; products that allow energy saving; fair trade products; products with less packaging material.

The figure 13 (table on Products' aspects) shows the percentage of the classification of such features according to the number of times they were placed in one of the six possible ranking positions. As can be seen, 'price' was considered the most important feature as it was voted as number '1' feature for 40% of the participants. One the other hand, 'products made of recyclable/recycled materials' was not voted as number '1' by any of the participants (0%). It is also important to note that 'products made by natural ingredients' was the second feature most voted as number '1' (32%) as well as the most voted as number '2' (24%). In addition, 'products with less packaging material' as well as 'fair trade product' were the features most voted as the less relevant feature, or as number '6', both with 32% of the votes.

The second question meant to find out more about the customers' habits concerning household trash recycling. The figure 13 (middle section) shows the percentage of customers that declare to separate or not their garbage for recycling. It also describes the reason why they would or would not do so.

As can be seen, most of the participants (67.7%) declared to collect/separate their house trash for recycling. From them 57.3% do so because they believe it is important, while 10.4% declared to recycle their garbage because an 'easy to do' collection system is provided. However, from the 32.3% that declared not to

recycle, 72.8% justified it by saying that ‘there is no collection system which makes it easy to do’. The remaining 27.2% declared not finding it important to recycle.

In the third question of the survey, the participants were asked to classify how often they talk to friends, neighbours and relatives about environmentally friendly products and activities. The figure 13 (lower section) shows this classification in terms of frequency. As can be seen almost half of the participants (46%) stated to ‘often’ discuss such subjects among friends and family; while 38% declared to do it ‘rarely’. In addition, 12.7% said to ‘always’ talk about environmentally friendly issues, while only 2.8% declared never to talk about it.

The following information shows the data collected from each store separately.

CHOOSE. by Olive Ventures

Products' Aspects	Importance from 1 to 6 (%)					
	1	2	3	4	5	6
1. Products made of natural ingredients	22.2	29.6	3.7	22.2	18.5	3.7
2. Products made of recyclable/recycled materials	3.7	22.2	37.0	18.5	11.1	7.4
3. Price	59.3	18.5	3.7	3.7	11.1	3.7
4. Products that allow energy saving	3.7	11.1	33.3	14.8	22.2	14.8
5. Fair trade Products	7.4	14.8	7.4	22.2	11.1	37.0
6. Products with less packaging material	3.7	3.7	14.8	18.5	25.9	33.3

choose

100% = 27

02. Do you collect/separate your household trash for recycling?

YES Why?

52.7% I believe it is important.

16.7% There is a collection system which makes it easy to do.

NO Why?

0.0% I don't believe it is important.

30.6% There is no collection system which makes it difficult to do.

neighbours and

03. How often do you talk to your friends, neighbors and relatives about environmentally friendly products and/or activities?

10.2% Always

46.9% Often

41.1% Rarely

2.6% Never

Participant information

Gender:

35.1% Male

64.9% Female

Age group:

20.0% below 20

55.0% 20 to 30

15.0% 30 to 40

10.0% above 40

Educational Level:

0.0% Below Secondary

7.5% Secondary

7.5% Post Secondary

20.0% Polytechnic - Other Diploma

85.0% University - Degree, Masters & Ph. D

Figure 14. Illustration of the data collected from the survey 2

In the first question of the survey, the participants were asked to rank in the order of importance to them what would be the relevance of the following products' features.

The figure 14 (products' aspects table) shows as a percentage the number of times each feature was placed in one of the six possible ranking positions. As can be seen, 'price' was considered the most important feature as it was voted as number '1' feature for 59.3% of the participants. On the other hand, 'products made of recyclable/recycled materials', 'products with less packaging material' and 'Products that allow energy saving' were the least features voted as number '1' the three of them with 3.7% of the votes. It is also important to note that 'products made by natural ingredients' again considered the second feature most voted as number '1' (22.2%) as well as the most voted as number '2' (29.6%). In addition, 'products with less packaging material' as well as 'fair trade products', here the features most voted as the less relevant feature, or as number '6', with 37% and 33.3% respectively.

The second question meant to find out more about the customers habits concerning household trash recycling. The figure 14 (middle section) shows the percentage of customers that declare to separate or not their garbage for recycling. It also describes the reason why they would or would not do so.

As can be seen, most of the participants (69.4%) declared to collect/separate their house trash for recycling. From these, 75.9% do so because they believe it is important, while 24.1% declared to recycle their garbage because an 'easy to do' collection system is provided. However, from the 30.6% that declared not to recycle, 100% justified it by saying that 'there is no collection system which

makes it easy to do'. Therefore none of the participants (0.0%) declared not finding it important to recycle.

In the third question number of the survey, the participants were asked to classify how often they talk to friends, neighbours and relatives about environmentally friendly products and activities. The figure 14 (lower section) shows this classification in terms of frequency. As can be seen almost half f the participants (46.9%) stated to 'often' discuss such subjects among friends and family; while 41.1% declared to do it 'rarely'. In addition, 10.2% said to 'always' talk about environmentally friendly issues, while only 2.6% declared never to talk about it.

Simply Living

01. Products' Aspects

100% = 23

	Importance from 1 to 6 (%)					
	1	2	3	4	5	6
1. Products made of natural ingredients	39.0	34.8	8.7	8.7	8.7	0.0
2. Products made of recyclable/recycled materials	17.4	26.1	30.4	13.0	8.7	4.3
3. Price	17.4	26.1	26.1	8.7	8.7	13.0
4. Products that allow energy saving	4.3	8.7	17.4	8.7	34.8	26.1
5. Fair trade Products	21.7	4.3	8.7	26.1	13.0	26.1
6. Products with less packaging material	0.0	0.0	8.7	34.8	26.1	30.4

simplyliving

02. Do you collect/separate your household trash for recycling?

YES Why?

74.1% I believe it is important.

3.7% There is a collection system which makes it easy to do.

NO Why?

3.7% I don't believe it is important.

18.5% There is no collection system which makes it difficult to do.

03. How often do you talk to your friends, neighbours and relatives about environmentally friendly products and/or activities?

15.6% Always

46.9% Often

34.4% Rarely

3.1% Never

Participant information

Gender:

11.5% Male

88.5% Female

Age group:

3.2% below 20

42.0% 30 to 40

35.3% 20 to 30

19.3% above 40

Educational Level:

0.0% Below Secondary

6.5% Secondary

3.2% Post Secondary

9.7% Polytechnic - Other Diploma

80.6% University - Degree, Masters & Ph. D

Figure 15. Illustration of the data collected from the survey 3

In the first question of the survey, the participants were asked to rank in the order of importance to them what would be the relevance of the following products features.

The figure 15 shows as a percentage the number of times each feature was placed in one of the six possible ranking positions. As can be seen, differently from CHOOSE, ‘products made by natural ingredients’ was considered the most important feature as it was voted as number ‘1' quality by 39.0% of the participants. This was also the most voted feature as number ‘2' with 34.8% of the votes. On the other hand, ‘products with less packaging material’, was not voted as number ‘1' by any of the participants (0%). It is also important to note that ‘price’ and ‘products made of recyclable/recycled materials’ were considered the second feature most voted as number ‘1', both with 17.4% of the votes. In addition, ‘products with less packaging material’ was voted as the less relevant feature by 30.4% of the participants; followed by ‘fair trade products’ and ‘products that allow energy saving’ with 26.1% of the votes.

The second question meant to find out more about the consumers’ habits concerning household trash recycling. The figure 15 (middle section) shows the percentage of consumers that declare to separate or not their garbage for recycling. It also describes the reason why they would or would not do so.

As can be seen, most of the participants (77.8%) declared to collect/separate their house trash for recycling. From them 95.2% do so because they believe it is important, while 4.8% declared to recycle their garbage because a ‘easy to do’ collection system is provided. However, from the 22.2% who declared not to recycle, 18.5% justified it by saying that ‘there is no collection system which

makes it easy to do'. The remaining 3.7% declared not finding it important to recycle.

In the third question number of the survey, the participants were asked to classify how often they talk to friends, neighbours and relatives about environmentally friendly products and activities. The figure 15 (lower section) shows this classification in terms of frequency. As can be seen almost half of the participants (46.9%) stated to 'often' discuss such subjects among friends and family; while 34.4% declared to do it 'rarely'. In addition, 15.6% said to 'always' talk about environmentally friendly issues, while only 3.1% declared never to talk about it.

6.3.1 CHOOSE. by Olive Ventures

When asked to describe a typical 'CHOOSE' customer James provided the following profile:

> *"…it is thankfully wide; ranging from students to executives; locals to tourists; housewives to retirees. It is true that most of our clients tend to come from middle-income and above. However the economic demography is shifting thanks to greater awareness, as well as more affordable options available to consumers now."*

He believed that most of their customers prioritise their interests in the products commercialised by the shop according to the rank below:

1st Price

2nd Products made from natural ingredients

3rd Energy saving

4th Made from recyclable/recycled materials

5th Fair trade

6th Less packaging

According to James most of them would recycle their household trash believing that it is important to do so.

He also believes that most of their customers 'always' discuss environmentally friendly issues with their friends and family.

6.3.2 Simply Living

When asked to describe a typical 'Simply Leaving' customer, she portrayed the following profile:

"About 70% foreigner / 30% local both male and female age: 20's-40's working professionals."

She believed that most of their customers prioritise their interests in the products commercialised by the shop according to the rank below:

1st Products made from natural ingredients

2nd Made from recyclable/recycled materials

3rd Fair trade

4th Price

5th Energy saving

6th less packaging

According to Barbara, most of them would recycle their household trash believing that it is important to do so.

She also believes that most of their customers ‘sometimes’ discuss environmentally friendly issues with their friends and family.

7 ANALYSIS AND DISCUSSION OF THE RESEARCH FINDINGS

This chapter presents an integrated discussion of the three sources of data collected for this research. The previous chapter presented in detail the findings from each of these sources, namely, the companies' interview, the checklist and the survey. The focus of this chapter is to identify the patterns of design strategies being implemented in the packaging industry of Singapore based on the combined analysis of all data collected from these three sources. The first section illustrates and discusses some of the companies' answers to the interview in comparison to the results obtained from the 31 companies analysed through the checklist. The second section introduces the data gathered from the survey. This allows a comparison between the strategies being taken by the companies analysed and the Singaporean consumers' expectations and responses to some of these strategies. Finally, some important theoretical features related to design strategies, sustainable development and the packaging industry of Singapore are discussed based on the research findings.

7.1 The companies' understanding of 'Sustainable development' and how it may influence their design strategies preferences

The charts below show the companies' responses to some of the questions of the interview as to facilitate their comparison. As can be seen, they allow the contrast between the local and the multinational companies analysed as well as within the two groups.

One of the goals of the interview was to learn more about the companies' understanding of sustainable development. The figure below illustrates how each of the three aspects of sustainable development has been considered by the two groups of companies analysed (local and multinational companies) when defining 'sustainable development'.

Figure 16. Answers to the first question of the companies' interview

As can be seen in the first half of the chart, the three local companies interviewed have considered environmental aspects while defining 'sustainable development'. However, none of the companies have mentioned 'socio-cultural' aspects, and only one company has considered economic aspects. Perhaps it is not surprising that all the local companies have considered environmental aspects while defining 'sustainable development' given that 80.6% of the companies analysed through the checklist have considered environmental aspect while developing their products (see figure 8). Moreover, according to Lélé, (1991) most interpretations of sustainability consider it as *"the existence of the ecological conditions necessary to support human life at a specified level of well-being through future generations."* According to him, that should be referred to as 'ecological sustainability', since it mainly considers environmental

aspects. Additionally, economic aspects were mentioned only by one of the companies during the interview. However, the checklist shows that 100% of the companies analysed had the production cost of their products minimised as a consequence of the strategies that were put into practice. The lack of knowledge or misunderstanding of the meaning of sustainable development may also explain why most of the companies have not included economic aspects as well as social aspects as part of their definition.

The second half of the chart shows the considerations from the three multinational companies interviewed. It shows that two of the three companies have considered environmental aspects while defining 'sustainable development' and only one of them has mentioned 'socio-cultural' aspects. In addition, all three companies have considered economic aspects. Moreover, one of the three multinationals was the only company interviewed to equally recognise the importance of the three aspects. It is then reasonable to argue that since multinational companies could have experienced the implementation of sustainable development regulations in other countries; they could have also developed a broader understanding of its meaning.

The last column of the figure shows whether the companies' definitions of 'sustainable development' have considered it as an integral part of the company's day-to-day activities in its strategic planning.

As can be seen, only one local company and one multinational company have recognised 'sustainable development' as an integrated part of their business. Moreover, the local company that has considered it as an integrated practice had earlier considered only the environmental aspects while defining

‘sustainable development’. This suggests that what in fact being integrated to the company’s day-to-day activities is what Lélé, (1991) defines as ‘ecological sustainability’.

On the other hand, MnC02 has considered ‘sustainable development’ as an integrated part of their business and has also been the only company that has equally recognised the three aspects here discussed. Perhaps, of the six companies interviewed this company is the only one which has a full understanding of the meaning of ‘sustainable development’ and the importance of its full integration to the company’s daily activities.

Let us now take another look into the companies’ strategies in relation to each of the life cycle phases. As previously shown (see table 1), the table below illustrates the strategies being analysed as well as the percentage of companies that resorted to each of these strategies (defined as active companies). However, this table also shows two additional columns which illustrate the percentage of Local Companies and Multinational companies within the active companies (AC) that resorted to each of the strategies analysed. Therefore, assisting on the comparison between the results obtained from the interviews and from the checklist.

Design strategies by type of impact and Life cycle phase	% of Active companies (AC)* per strategy	% of LC within AC per strategy	% of MnC within AC per strategy
Environmental impacts			
Raw materials, extraction and processing			
1. Is the amount of raw materials used in the products minimised?	77	42	58
2. Is the amount of restricted materials used in the products minimised or eliminated?	10	100	0
3. Is the amount of materials coming from certified suppliers maximised or totally achieved?	13	50	50
4. Is there implementation or optimisation of energy conservation practices during raw materials' extraction and processing phases?	0	0	0
Production, manufacturing			
5. Is the number of types of materials used in the products minimised?	16	40	60
6. Is the amount of materials used in the products minimised during production phase?	68	43	57
6A. Reduction, elimination of components?	16	40	60
6B. Packaging light?	65	40	60
7. Is the use of recycled and/or renewed materials implemented or optimised during production phase?	19	29	71
8. Is the production technology optimized in order to minimise, eliminate emissions to air, effluents, waste or energy use?	32	30	70
9. Is the company's internal waste recycled/reused within the company or sent to recycling/reuse?	19	17	83
Distribution			
9. Is the amount of materials used in the distribution of the products minimised?	29	11	89
10. Is the transport fuel and/or technology optimized in order to minimise, eliminate emissions to air and/or or energy use?	0	0	0
11. Are there alterations in the distribution packaging to improve case, palletisation, transport efficiency and/or reduce waste?	32	50	50
12. Are there alterations in the distribution packaging to make it reusable?	26	50	50

Table 4 (continued). Percentage of companies that resorted to each of the strategies studied II

Design strategies by type of impact and Life cycle phase	% of Active companies (AC)* per strategy	% of LC within AC per strategy	% of MnC within AC per strategy
Consumption, use			
13. Are there products made for refill and/or reuse?	23	29	71
14. Are the products easily disassembled for discarding and or recycling?	61	37	63
15. Have potential barriers to recycling removed: use of additives, embedded metal threads in plastics, paint, multilayer material, use of materials of unknown composition and or difficult to separate?	19	67	33
16. Are there alterations in the product to reduce waste and/or energy use during consumption phase?	19	67	33
End of life			
17. Are the materials used in the products easy to identify by type and separate?	61	42	58
18. Are the products easily disassembled for reuse, recycling or composting at the end of its life?	58	44	56
19. Are the products developed in accordance with and/or to facilitate the local solid waste management system?	0	0	0
Social impacts			
Raw materials			
20. Is the company committed to maintaining a productive, healthy and safe environment for the employees during raw materials' extraction and processing phases?	0	0	0
21. Is the company committed to have only certified suppliers?	6	100	0
Production and assembly			
22. Is the company committed to maintaining a productive, healthy and safe environment for its employees as well as its subcontract companies'?	3	0	0
23. Are the adverse health/safety impacts for the local community taken into account during the products' production phase?	3	0	0
24. Does the company promote environmental awareness among their employees?	19	50	50
25. Does the company promote environmental awareness among the community?	39	25	75

Table 5 (continued). Percentage of companies that resorted to each of the strategies studied II

Design strategies by type of impact and Life cycle phase	% of Active companies (AC)* per strategy	% of LC within AC per strategy	% of MnC within AC per strategy
26. Are the adverse health/safety impacts for the global community taken into account during the products' distribution and retail phases?	3	0	100
Consumption, use			
27. Does the company promote environmental awareness during the products' use?	19	17	83
28. Are the adverse health/safety impacts for the local community taken into account during the products' consumption phase?	3	0	100
29. Are the adverse health/safety impacts for the global community taken into account during the products' consumption phase?	0	0	0
End of life			
30. Are the adverse health/safety impacts for the local community taken into account during the products' end of life?	6	100	0
31. Are the adverse health/safety impacts for the global community taken into account during the products' end of life?	6	100	0
Economic impacts			
32. Do the altered products cost less than the previous versions?	100	42	58
Decision making in all phases			
33. Does the company make use of software or other tools for guiding decision making regarding environmental and/or social impacts during product development phases?	6	50	50

Table 6 (concluded). Percentage of companies that resorted to each of the strategies studied II

Legend Table 2

* AC – Active companies: companies that resorted to the strategies analysed.

LC – local companies

MnC – Multinational companies

The figure 17 summarises the data presented on the first column of table 1 as to facilitate its analysis. The graph shows the percentage of companies that resorted to each of the strategies studied and its correspondent life cycle phase which can be identified by different colours.

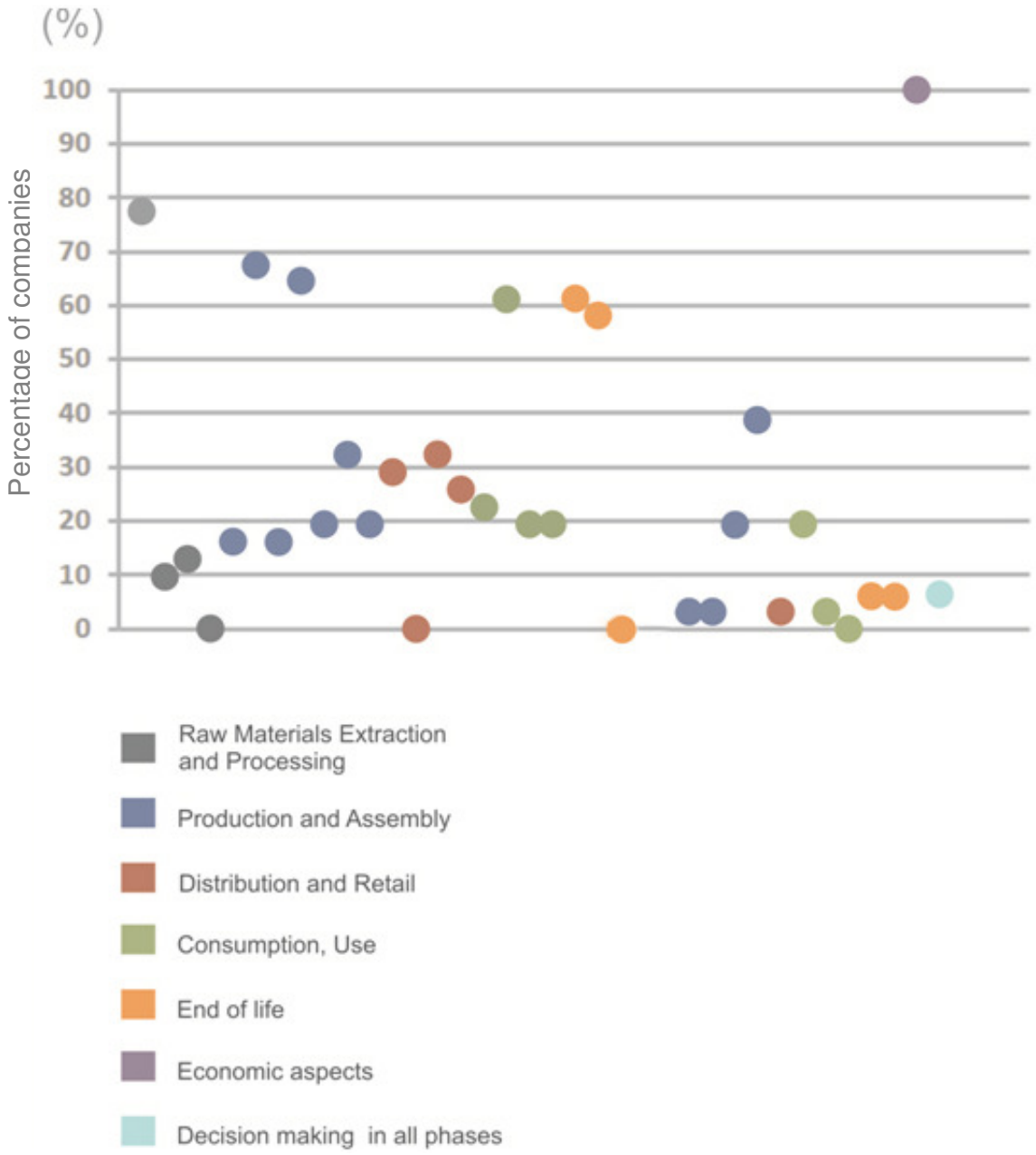

Figure 17. Illustration of the checklist results

Figure 17 shows a strong preference by the companies to resort to strategies that directly reflect on the minimisation of environmental impacts. The minimisation of raw materials as well as materials used during the production phase were the most preferred strategies by the companies analysed. They were implemented by 77% and 68% of companies respectively (see table 2 questions 1, 6 and 6B)

The interview also aimed to find out how many (number) or how much (as a percentage) of the companies' products being currently commercialised would be categorised by them as 'sustainable products'. Figure 18 below shows the classification of the products by each of the companies.

	No.	%
LC01	zero	zero
LC02	all	100
LC03	all	100
MnC01	all	100
MnC02	all	100
MnC03	all	100

Figure 18. companies' classification of products' sustainability

As can be seen, two of the three local companies interviewed consider all of their products as 'sustainable '. On the other hand, one of the local companies does not classify any of its products as a 'sustainable product'. In addition, all the multinationals interviewed would classify all of their products as 'sustainable', according to the companies' understanding of 'sustainable product'.

There have been several studies presenting critical reviews on 'sustainable development' (Lélé (1991); Brown et al.(1987); Barbier (1987); Tisdell (1988) and Redclift, 1987)). In addition, it has been embraced as the new paradigm by nongovernmental as well as governmental organisations in the past few decades. However, the present study indicates that the lack of consistency in its interpretation is still an issue, and therefore continuous work needs to be done in order to clarify the extent of its meaning and significance for industries as well as for governments and policy makers. In the case of Singapore the National Environmental Agency is usually the organisation responsible for bringing different sectors together towards sustainable development.

7.2 The relevance of the Singapore Packaging Agreement

More than half of the companies analysed have joined the Singapore Packaging Agreement since 2007. Therefore, it is also important to consider the influence of the Agreement on the companies' design strategies' preferences in the past few years.

The participating companies have made some progress in reducing waste since the signing of the Agreement. In the first year (from 1 Jul 2007 to 30 Jun 2008), the companies, as a group, reduced 850 tons per year of packaging waste, and up to 17% of packaging usage for individual food and beverage products, saving up to S$1.5 million in packaging costs. In the second year (from 1 Jul 2008 to 30 Jun 2009), the companies implemented further improvements which enabled an additional reduction of about 800 tons per year of packaging waste, and potential savings of about S$1.4 million in packaging cost.

According to the agreements fact sheet, the main objectives of the SPA are to:

> *"Reduce waste from product packaging through optimising production processes, redesigning the packaging, and increase the reuse and recycling of packaging waste; "*
>
> *"Raise awareness and educate consumers on reducing waste, which is important since consumers' actions (e.g. consumers' selection of products with less packaging and their participation in recycling) have a direct impact on the success of the programme."*

The following guidelines are used for the signatories' assessment:

1. Packaging waste avoidance
2. Recycling or reuse of packaging waste
3. Consumer education
4. Use of recyclable/recycled packaging material
5. Reduction of other waste

According to the CEO of the Singapore National Environmental Agency, Mr Lee Yuen Hee:

> *"The voluntary agreement is aimed at reducing packaging waste at source and to enhance our recycling programme. Through this agreement, I hope to further strengthen the government-industry-community partnership to reduce the amount of waste disposed of in Singapore" (3R Packaging Awards 2008 Communication Folder)*

The Packaging Agreement's guidelines as well as its first results are in agreement with the checklist outcomes. The checklist shows (see table 1) that

most of the companies analysed have focused on strategies that directly minimise environmental impacts. As previously highlighted, it shows a strong preference by the companies to resort to strategies that reflect on the minimisation of raw materials as well as materials usage during the production phase. That is 77% and 68% of companies respectively (see table 2 questions 1, 6 and 6B) in accordance with the Packaging Agreement guidelines. Therefore, this study also shows the possible influence of the agreement on the companies' preferences to strategies that minimise packaging waste.

All three local companies interviewed have signed the Singapore Packaging Agreement while two (MnC01 and MnC02) of the three multinationals have signed it. However, when asked whether the agreement has had any impact on the company, only one local company (LC02) and one multinational (MnC02) have acknowledged the influence of the agreement in the companies' activities. The two companies have claimed that agreement has positively helped or changed the company somehow. LC02 recognises the importance of the meetings organised by the Singapore Packaging Agreement, as they allow them to collaborate and learn from other companies' experiences. On the other hand MnC02 stresses that the agreement made them realise how important it is to measure the impact of their improvements.

> *"What it pushes us to do is to be a bit more analytical about what I do, measure it a bit more. Because typically, in the past, I would implement certain innovation but I wouldn't follow as carefully what the impact was. And now we are much more aware of measuring the impact of our improvements, because it is useful for us to know… It is important to us*

to understand and be able to prove to ourselves that we are continuously reducing our resource utilisation."

Hence, even though this study shows the possible influence of the agreement on the companies' preferences to strategies that minimise packaging waste, it would be important to clarify how the companies make their decisions during the products' development process.

The following charts give us a glimpse on the methods used by the companies to assess and plan the products' development process. They also illustrate how the companies make decisions regarding the strategies here studied.

The figure 19 shows whether the supply chain is taken into account or not by the companies interviewed while developing their products.

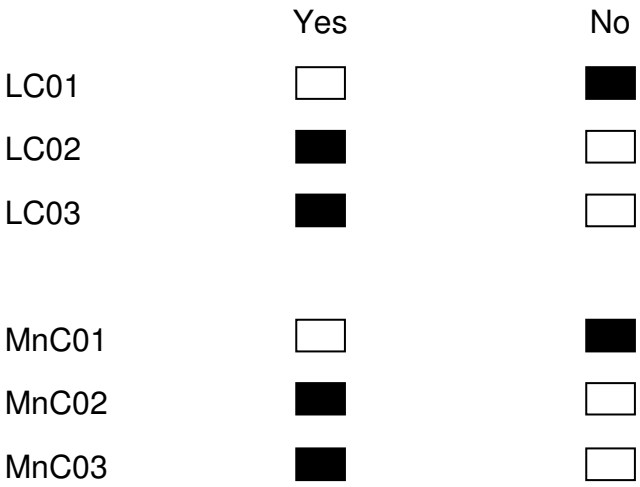

Figure 19. Answers to question 11 of the companies' interview

It shows that two of the three local companies interviewed (LC02 and LC03) have declared that the supply chain is taken into account. Similarly, two of the

three multinationals interviewed (MnC02 and MnC03) also have claimed to take it into account.

According to Geoffrey et al. (2001):

> *"The supply chain is not a chain of businesses with one-to-one, business-to-business relationships, but a network of multiple businesses and relationships. Executives are becoming aware that the successful co-ordination, integration and management of key business processes across members of the supply chain will determine the ultimate success of the single enterprise"*

Moreover, the life cycle assessment is one of the supporting instruments used for supply chain management (Geoffrey et al. 2001 and Laínez et al. 2008). The figure below illustrates whether the companies interviewed have a life cycle approach or not while developing their sustainable products.

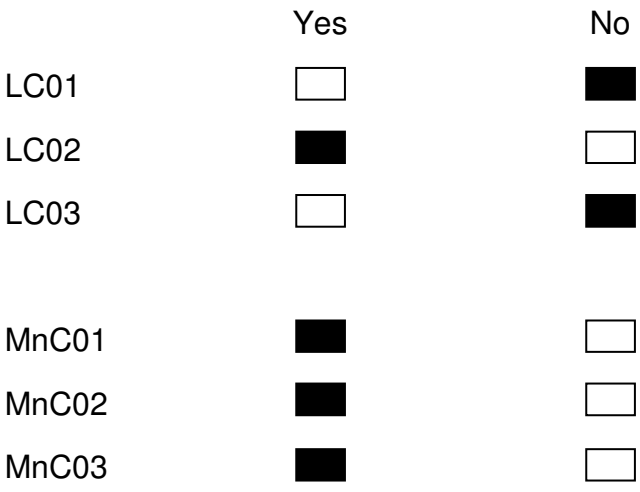

Figure 20. Answers to question 12(a) of the companies' interview

It shows that only one of the three local companies interviewed (LC02) and all three multinationals use life cycle approach while developing their products.

The next section introduces the companies' answers regarding how they assess the life cycle of their products.

As previously discussed, LCA allows designers and other professionals to make knowledgeable decisions on where the most impacts are and what design strategies need to be developed to address such impacts. In order to make such complex analysis feasible, there is an extensive collection of LCA tools, ranging from inexpensive online tools to the more complex design tools used by larger organisations.

The figure below shows whether or not the companies interviewed use frameworks and/or tools for the life cycle approach.

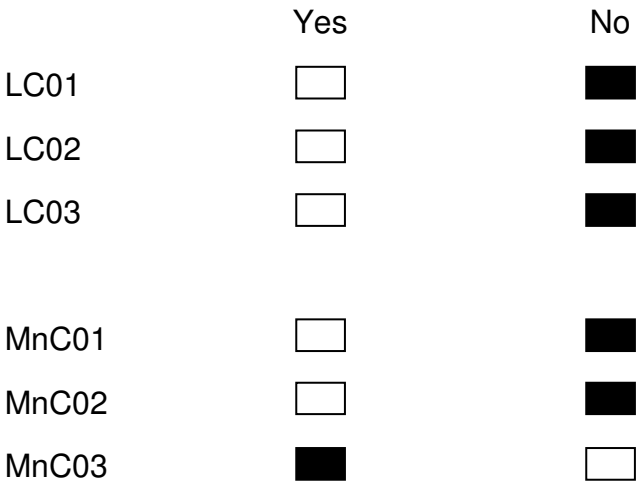

Figure 21. Answers to question 12(c) of the companies' interview

As can be seen, all three local companies and two of the multinationals (MnC01 and MnC02) deny the use of any frameworks and/or tools for the life cycle

approach. MnC03 is the only company to recognise its use. Moreover, according to the checklist results, only 2 from the 31 companies analysed have claimed to make use of some sort of tool.

The results show that there is nearly non use of LCA tools by the Singapore packaging industries. However, the checklist and the interviews show that most of the companies have resort to the same types of strategies: 77% of the companies analysed have minimised the amount of raw materials used in the product; and 68% of them have minimised the amount of materials used during the products production process; therefore minimising packaging waste. (see table 2)

The concentration in such strategies reflects the importance that has been given to the reduction of material. It is clear that reducing the amount of material used also minimises cost (that was confirmed by 100% of the companies). The concentration on these strategies also reflects that the economic and environmental impacts are the ones being mostly considered, while socio-cultural impacts have almost not been taken into account by most of the companies. Therefore, I would like to argue that the *Packaging Agreement* could also be influencing this decision.

The main objectives of the agreement are to:

*"Reduce waste from product packaging through optimising production processes" and to "raise awareness and educate consumers on reducing waste, "(*SPA fact sheet)

Given the large effort of the Singaporean Government and the high number of signatories of the program, it is reasonable to argue that *Packaging Agreement* could be inducing such a pattern. The success of the program clearly agrees with the case study results. However, it is important to highlight that the same strategy may not always be suitable to every product.

In this context I would like to highlight the fact that, if the products from all companies' study were assessed through a life cycle approach, it is likely to lead to different results for each of them.

7.3 The importance of systemic thinking and how a Life cycle approach could make a difference

I would like to highlight the significance of systemic, interdisciplinary and holistic thinking in this context, since I are dealing with research fields that are closely related to nature and environmental studies. Moreover, I would like to argue that an integrative perspective within the framework of Industrial Design is fundamental in the context of sustainable development. Such argument is supported by some of the existing Industrial Design approaches such as eco-design and sustainable design.

As previously discussed, dealing with complex systems can be a difficult task since many aspects need to be considered and carefully analysed from different points of view. A product life cycle can be considered as a complex system (David, 1995 and Ny et al. 2006)

Hence, it is important to acknowledge the relevance of systemic thinking when dealing with a product life cycle. A broader and holistic analysis could perhaps identify that greatest impact are actually occurring in other life cycle phases and therefore other strategies would be more suitable for that specific case.

Several frameworks and tools have been developed as simplified approaches to such complex analysis allowing engineers and designers to make informed decisions regarding the products impact.

Although it seems clear that minimising the amount of material used for each product would lessen its environmental impact. That is not quite the case when dealing with a complex system.

As previously discussed on pages 39 and 40, the Heller and Keoleian, (2000) example stresses the importance of a systemic view and moreover, the significance of performing a detailed study for each system considered, when dealing with life cycle assessments. Their study shows extremely different values for energy inputs in different life cycle phases when different products are considered.

The boundaries that have been set for this study specify that only the packaging life cycle would be considered so that the design strategies could be evaluated. However, the system that should have been considered by each company includes the product itself plus its packaging (see figure 6). In most of the cases studied here, these products are food and beverage products and as shown by Heller and Keoleian, (2000) it is important to emphasise the significance of a detailed analysis in order to detect the impacts that should be

targeted in each of the life cycle phases for each product considered, as they can differ significantly.

7.4 The consumers and the environmental awareness in Singapore.

One of the main objectives of the Singaporean government is also to educate consumers in order to reduce waste:

> *"Raise awareness and educate consumers on reducing waste, which is important since consumers' actions (e.g. consumers' selection of products with less packaging and their participation in recycling) have a direct impact on the success of the programme."*
>
> *(SPA fact sheet, 2010)*

The need to learn more about the Singaporean consumer's attitude towards eco-friendly products was the main motivation for conducting the survey that was previously presented. Based on previous studies on environmentally friendly consumer behaviour (Hassan, 2010; Minton & Rose, 1997 and Roberts, 2000), the questions selected allowed the development of a profile regarding environmentally friendly consumers of Singapore. The profile includes gender, age group, and behaviour towards recycling initiatives, among other indicators.

Contradicting the main focus of the Packaging agreement and the results from the checklist, in which material reduction is strongly considered, the findings discussed on page 93 show that the minimisation of packaging material is apparently the least relevant aspect for the Singaporean consumers when

purchasing sustainable products. Moreover, they also show a large difference of importance given to each feature by the consumers. However, as previously seen, all features considered here are important and their significance may vary from product to product or system to system. Therefore, the education of consumers towards waste reduction or any other attitude regarding a sustainable life style should also encourage the system approach. Questions number two and three show a broader view of consumer's behaviour regarding their day-to-day activities.

Almost half of the participants showed to be interested in environmentally friendly products and activities (see pages 82-83). Moreover, the results obtained from the second question show the importance of having the necessary structure to encourage and facilitate consumers' day-today actions towards a more sustainable life style. A system approach in this case would also assist the education of consumers.

When analysing the results from both stores separately, no substantial differences were found. The stores are located in two different neighbourhoods and therefore the profile of the customers differs marginally. This could be the reason why some of the answers slightly differ.

8 CONCLUSIONS AND DIRECTIONS FOR FUTURE RESEARCH

8.1 The need to embrace a holistic approach

In the last section were discussed several topics related to the project presented here. These topics concern the relationship between the main aspects analysed in this study: The packaging industry and sustainable development in the context of Singapore.

Three different sources of data were developed and used to analyse such relationship: interviews, checklist and survey. The results have shown significant information about these aspects separately and most importantly about the interaction of these aspects in the context here discussed. The most significant finding is perhaps the need to embrace a more holistic approach. This requirement has shown to be extremely important not only to each of the topics discussed in the last section but especially to the integration of these topics.

Conclusions:

- There is lack of consistency in implementing sustainable development concepts. Further education campaigns to clarify and emphasise the relevance and significance for industries and policy makers are necessary.
- Focus of industries at the moment is minimising the material use, as a result of the ‘Packaging Agreement’.

- System boundaries used by the industries are limited and lacks integrated system thinking and life cycle perspective.

These conclusions directly reflect the need to embrace systemic thinking methods when dealing with such complex systems. Designers shape the development of products and services transforming the society and the environment (Papanek, 1971). The application of Industrial Design strategies towards sustainable development can reduce socio-cultural and environmental impacts significantly. A systemic and deep analysis of each system can review specific details that would not be considered otherwise. Therefore, such analyses would enhance the development of products towards sustainability.

"A multi-dimensional life cycle analysis covering also social and institutional aspects as it should be usual in the framework of DfS whenever suitable can help providing reliable decision support at a largely reduced effort for performing the assessment." (Spangenberg et al. 2010)

In the case of Singapore the National Environmental Agency is usually the organisation responsible for bringing different sectors together towards Sustainable development. Perhaps in this case, it would be interesting to have the government, the academia and the industries working in collaboration.

Several impacts that occur during the use of these products are often determined by consumer behaviour (Bhamra et al. 2008). Thus, it is reasonable to argue that it is also important to invest in environmental awareness education. In accordance with Spangenberg et al. (2010) Design for Sustainability must go beyond producing its own knowledge, also offering comprehensive solutions by engaging local and global communities. The

research findings have shown that the Singaporean consumers are beginning to engage in discussions and activities that promote sustainability. However, It is important to highlight the significance of a holistic approach while educating the consumers as well so that the transition towards sustainability can be achieved.

8.2 Future Research

The wide database developed for this study comprises companies' Interviews, consumers' surveys, and product samples' analysed through an extensive checklist created especially for the packaging industry of Singapore. This information could, for instance, be used on the development of a customised toolkit for the packaging industry of Singapore as to facilitate the implementation and integration of Industrial Design strategies within the sector in the direction of sustainable development. Moreover, the outcomes of this study include a critical analysis of the design tools and methods being used by the packaging industry in Singapore towards sustainable development; an analysis of some of the products developed by these companies within the given context; a profile of the consumers of the sector studied; as well as a profile of the packaging industry of Singapore regarding sustainable development initiatives with respect to local and global scenarios.

Further development could be done in several levels since the database developed here could be used by companies and government to assist the integration of industrial, political and academic levels towards sustainable development.

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.APPENDICES

Appendix 1 - Companies' interview questionnaire

1. How does the company understand the concept of "sustainability"?

2. How many products regarding sustainability aspects are being currently commercialised by the company?

3. Please specify the answers above according to the aspects below.

a. How many of these products do you launch per year?

Number: Percentage:

b. Please name one typical product of your company that represents such initiative:

c. What are the characteristics of this product that allow you to place it in such category (sustainable products regarding environmental issues)?

Regarding Socio-cultural aspects:

d. How many of these products do you launch per year?

Number: Percentage:

e. Please name one typical product of your company that represents such initiative.

f. What are the characteristics of this product that allow you to place it in such category (sustainable products regarding Socio-cultural issues)?

4. What is the importance of strategies regarding environmental aspects in your company?

5. What is the importance of strategies regarding socio-cultural aspects in your company?

6. Please describe the development process of a general product in your company.

7. In what aspects do the development process of the products mentioned in question 2 differ from the general product described above?

a. Regarding environmental aspects: In which phases of the product development do these differences occur?

b. Regarding socio-cultural aspects: In which phases of the product development do these differences occur?

8. Please describe the impact of the designers in the development process of a general product in your company.

9. Please indicate the phases in which the designers are involved:

10. How is the designer involved in the product development phases regarding the aspects below?

a. Environmental aspects:

b. Socio-cultural aspects:

11. Is the supply chain taken into account while developing sustainable products?

a. Yes No

b. If the answer is Yes, please explain how the supply chain assessment/management is done.

12. Is there a life cycle approach while developing sustainable products?

a. Yes No

If the answer is Yes:

b. Please explain how the life cycle of the products is taken into account.

c. Does the company use any frameworks and/or tool for the life cycle approach? Please specify the frameworks and/or tool used.

13. Has the company signed the Singapore Packaging Agreement?

14. How does the agreement change or help the company?

15. How do you communicate the strategies?

Appendix 2 – Survey

Product Design Strategies for Sustainable Development:
A case study of the Packaging Industry in Singapore

NUS National University of Singapore

01. When you buy a product what aspects would you usually consider?
Please number the options below in order of importance:

- ☐ Products made of natural ingredients
- ☐ Products made of recyclable/recycled materials
- ☐ Price
- ☐ Products that allow energy saving
- ☐ Fair trade Products
- ☐ Products with less packaging material

02. Do you collect/separate your household trash for recycling?

YES **Why?**

- ☐ I believe it is important.
- ☐ There is a collection system which makes it easy to do.

NO **Why?**

- ☐ I don't believe it is important.
- ☐ There is no collection system which makes it difficult to do.

03. How often do you talk to your friends, neighbours and relatives about environmentally friendly products and/ or activities?

- ☐ Always
- ☐ Often
- ☐ Rarely
- ☐ Never

Participant information

Gender:
- ☐ Male
- ☐ Female

Age group:
- ☐ below 20
- ☐ 20 to 30
- ☐ 30 to 40
- ☐ above 40

Educational Level:

- ☐ Below Secondary
- ☐ Secondary
- ☐ Post Secondary
- ☐ Polytechnic - Other Diploma
- ☐ University - Degree, Masters & Ph. D

Thank you!